

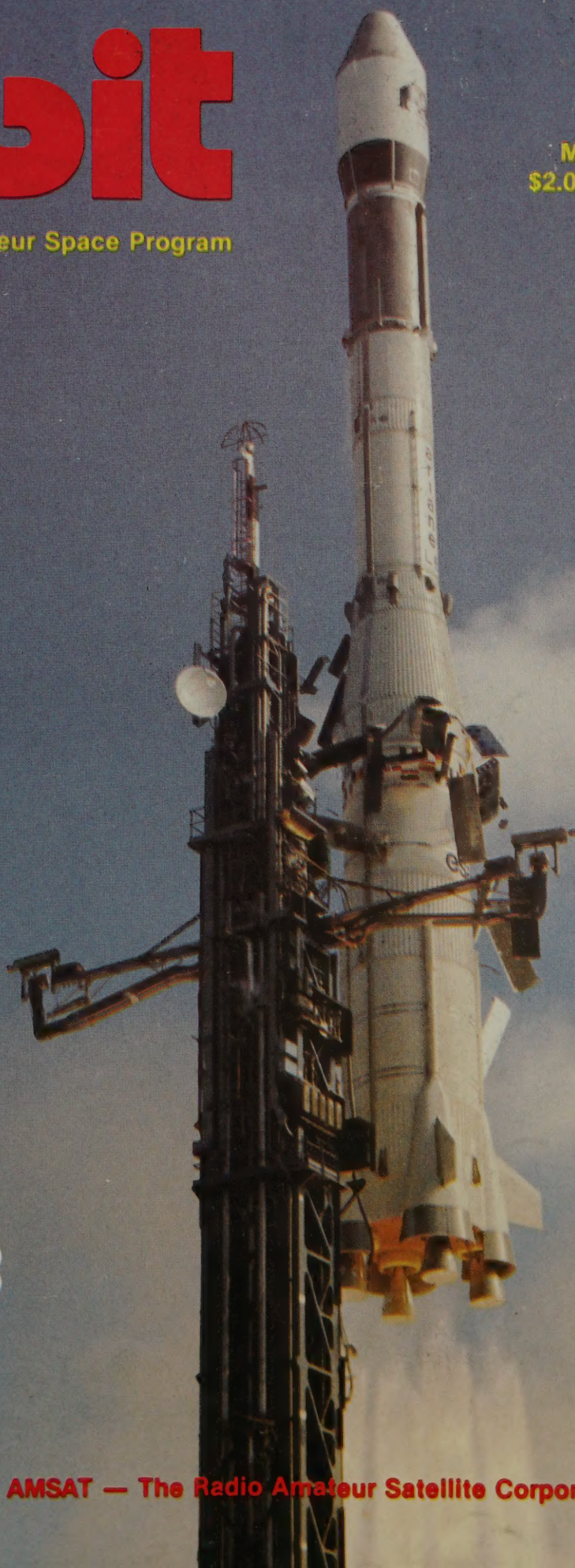
Orbit

Journal of the Radio Amateur Space Program

No. 14

May/June 1983
\$2.00 U.S.A./Canada

ANNÉE MONDIALE DES
COMMUNICATIONS
WORLD COMMUNICATIONS
YEAR
AÑO MUNDIAL DE LAS
COMUNICACIONES



Published by AMSAT — The Radio Amateur Satellite Corporation

ICOM UHF

Above and Beyond the Competition

IC-435

UHF MOBILE
2 Channel / 35 Watts

ICOM brings you the IC-435...a 35 watt, 100% duty cycle, 2 channel, synthesized UHF mobile transceiver in an incredibly compact package.

The IC-435 covers 450 — 470 MHz in two 10 MHz ranges. It features a noise cancelling microphone, 2.5 or 5 KHz diode programmable steps, multiple tone encoder (optional), LED channel readout, an advanced preset squelch design, and 5 watts of receiver audio.

All of these features come in a slim package that is only 2"H x 6-9/16"W x 11"D and...the front control panel can be remote mounted.

Other optional signalling features and/or a smart compatible version are available.

For more details contact ICOM America, Inc. or your local ICOM dealer.

IC-U12

UHF HANDHELD
12 Channel / 3 Watts

As a companion to the IC-435 or as a stand alone UHF transceiver, the IC-U12 is the perfect handheld. Available in 450 — 460 or 460—470 MHz versions, the IC-U12 is the smallest, most compact 12 channel UHF handheld anywhere.

The U12 features synthesized programming of standard and splinter channels (power adjustable to 2 watts), diode programming, and a heavy duty CM5 quick (1.5 hr) charge battery pack. The CM30 drop-in charger is required.

The IC-U12 is rugged, reliable, and is built using ICOM's proven handheld design. Included with the U12 is a rechargeable battery, a flexible antenna, and a belt clip. Interchangeable accessories, signalling options and slide-on battery packs complement the ICOM handheld line and are compatible with both UHF and VHF models.



Business Band Radio Division
3331 Towerwood Drive, Suite 307, Dallas, TX 75234, (214) 620-2780
Corporate Office/Sales & Service Center
2112—116th Avenue NE, Bellevue, WA 98004, (206) 454-8155

**With ICOM, the business
at hand is quality.**



May/June 1983
Volume 4 Number 3

ORBIT Staff

Editor in Chief: V. Riportella, WA2LQQ
Assoc. Tech. Ed.: Dom Mallozzi, N1DM
Assoc. Editor: Harold Winard, KB2M
Asst. Editor: Bob Ruedisuelli, W4OWA
Managing Editor: Bob Myers, W1XT
Advertising Dir.: Roger Soderman, KW2U

AMSAT Board of Directors

John Browning W6SP (Chairman), Tom
Clark W3IWI, Rich Zwirko K1HTV, Jan
King W3GEY, Pat Gowen G3IOR, Harry
Yoneda JA1ANG, John Henry VE2VQ

AMSAT Officers

President: Tom Clark, W3IWI
Exec. Vice Pres.: V. Riportella, WA2LQQ
Sr. Vice Pres.: J. Champa, K8OCL
V. P., Engineering Jan King, W3GEY
V. P., Operations: Rich Zwirko, K1HTV
V. P. Special Projects: Bill Brown K9LF
Asst. V. P., Eng. (Spacecraft):
D. Connors, KD2S
Asst. V. P., Eng. (System Analysis):
Phil Karn, KA9Q
Asst. V. P., Eng. (R&D):
S. Robinson, W2FPY
Asst. V. P., Ops. (S/C Ops):
D. Loughmiller, KO5I
Asst. V. P., Ops. (User Services):
Ralph Wallio, W0RPK
Treasurer: Roy Rosner, K4YV

Headquarters Office Staff

General Manager/Exec. Director:
William Lazzaro, N2CF
Office Manager: Martha Saragovitz

Editorial Office: P.O. Box 177,
Warwick, NY 10990

Advertising Office: 221 Long Swamp
Road, Wolcott, CT 06716

AMSAT: P.O. Box 27, Wash., DC 20044.
Telephone: 301 589-6062
Telex: 248-566

Second Class postage paid at Waterbury,
Conn. by ORBIT, 221 Long Swamp Road,
Wolcott, Connecticut 06716.

ORBIT (USPS 041-850) is published six
times per year for \$10. (inseparable from
membership dues of \$24).

Copyright © 1983 by AMSAT. Contents
may be reproduced without specific per-
mission provided proper credit is given,
unless otherwise stated and copies are
sent both to AMSAT and to the author.
Opinion expressed is not necessarily that
of AMSAT.

CONTENTS:

Technical Features:

4 Tracking Phase III Type Satellites with the *Satellipse*

By K. J. Deskur, K2ZRO

*The inventor of the famous Satellabe describes a new
tracker for elliptical orbits.*

10 The Phase III IFDEM PSK Telemetry Beacon Demodulator

By John DuBois, W1HDX

*The OSCAR 10 Command Chief describes the circuit and
function to extract data and clock information from the
PSK signals.*

13. AMS-81 Project Status

By Ralph Wallio, W0RPK

*A simple and inexpensive way to automate your AO-10
tracking chores is explained by the Project Manager.*

16. AO-10 Ground Station Analysis

By Hasan Schiers, N0AN

*Ever wonder how to calculate the noise figure of your
system? Noise Temperature? Here's how to go about it.*

Informational Topics:

20 Big is Better in Antennas

By WA2LQQ, KB2M, and N4QQ

*A photo essay describes AMSAT Amateurs and Scientists
using super antennas to bring EME to hundreds!.*

32 AO-10, The First Two Weeks By Vern Riportella, WA2LQQ

*A reprint of the early days of OSCAR 10 as reviewed in
Amateur Satellite Report.*

Departments:

3 Ellipsis . . . By Harold Winard, KB2M

9 Letters

28 AMSAT News

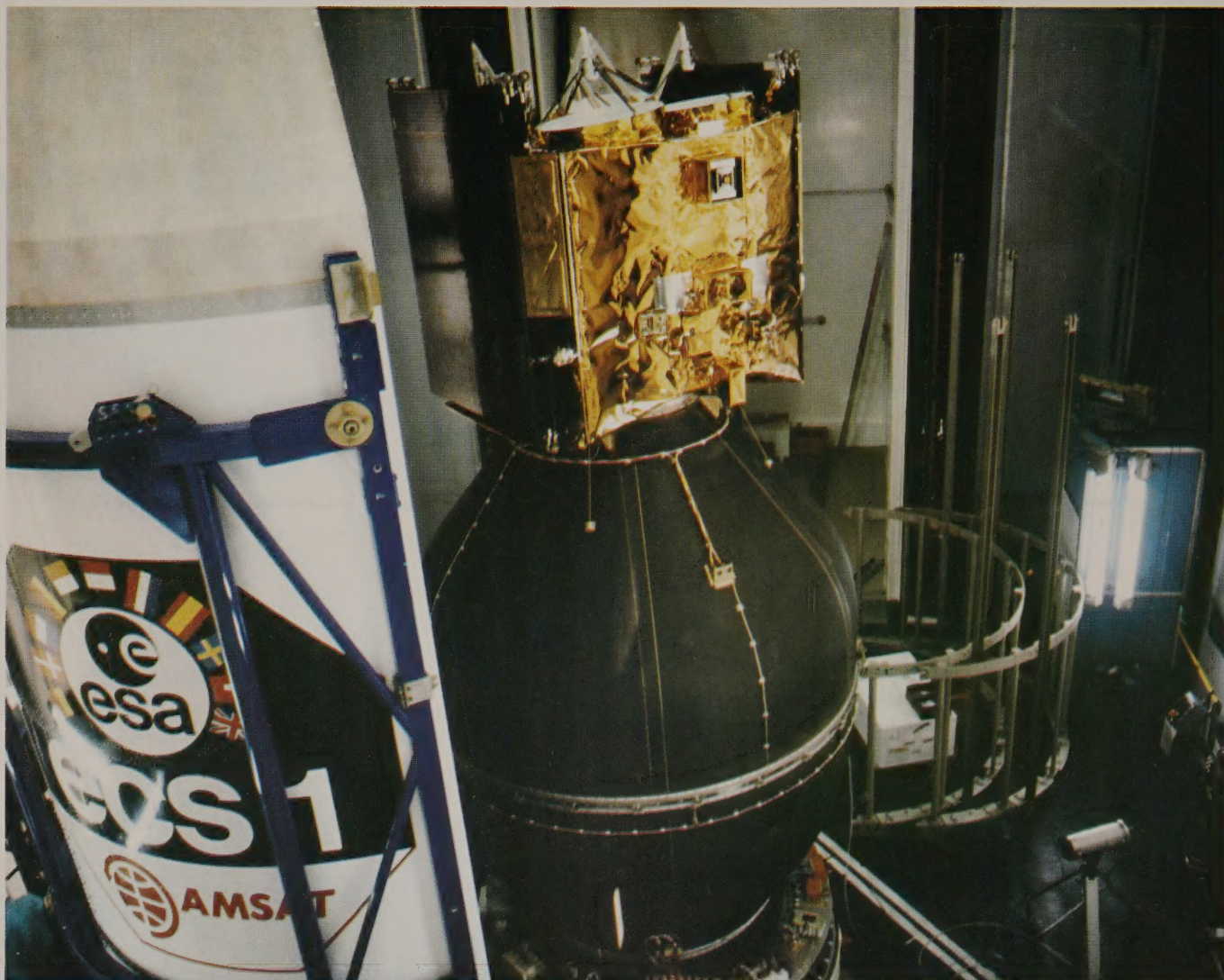
35 Satellite Log By Geoffrey Falworth

24 Worldwide Satellite Activity By Pat Gowen, G3IOR

27 W6 Space Philosopher By John Browning, W6SP

26 Around the World By Kaz Deskur, K2ZRO

Our Cover: Taken just a few seconds after ignition, this ESA sup-
plied print shows the power and beauty of the Ariane L6 launch with
ECS-1 and AMSAT-OSCAR 10 aboard.



ECS-1 atop the SYLDA with Phase IIIB inside. The fairing bearing the logos is about to enshroud the payload.

Comets

New AMSAT T-Shirts!

You'll be *looking good* and *feeling proud* in your new "AMSAT . . . Future Now" T-Shirt. Celebrate the launch of OSCAR 10 and a future of great operating for only \$7.50 donation. Sizes: small, medium, large, and ex-large. Please specify. Send to AMSAT Headquarters, Post Office Box 27, Washington, DC 20044. Supplies are limited.



Ellipsis...

*An Editorial by Harold Winard, KB2M**

Dawn of a New Day

If you were one of the many thousands of radio amateurs who listened to the live coverage of the AMSAT-OSCAR 10 launch, you may well have experienced the same emotions we did when word came from the launch facility in French Guiana: "Event 13" was nominal. Event 13 was the separation of AMSAT-OSCAR 10 from the Ariane launch vehicle and was, as satellite afficianados like to think of it, the birth of a new earth satellite.

Was it thrilling? Most certainly. Was it exciting? After the long wait, almost 37 months since the loss of Phase IIIA, it was more than exciting. It was downright exhilarating. This was no ordinary OSCAR (if I can take the liberty of calling any OSCAR launch "ordinary"), this was Phase III, the dawn of a very new day for amateur radio.

Not since radio amateurs proved that frequencies far above 1.8 MHz would support very long distance communication has the amateur radio world had so potent a symbol. As it loops its way from apogee to perigee and back, AMSAT-OSCAR 10 proves that radio amateurs have finally removed themselves from the vagaries of the ionosphere. Long distance communication — reliable communication, both voice and data — is now possible for hours at a time. An observer perched on one of AO-10's antennas would, at some apogees, view areas enveloping some 80% of all the world's amateurs.

But we said that AO-10 is a symbol; it is not yet a tool. And a tool it must certainly become if all the hours, days, and years of dedicated work will be rewarded. Use of the satellite by the world's radio amateurs will bring a plentiful return on the investments so carefully made these past seven years or so. Indeed, as more and more radio amateurs join the ranks of satellite users, the greater will be the return and the more powerful AO-10 will become as both a tool and a symbol of amateur radio.

But active involvement in the Amateur Space program requires a commitment to its future. That's a word many of us dread — *commitment*. For some it means serving on some committee that gobbles up too much of our spare time. For others it means some financial obligation that siphons away the money we could use on some more immediate pleasure; a new low-band rig perhaps.

Commitment need not be a dirty word, however. It doesn't have to separate us from our interests in life. A commitment to the amateur space program brings with

it a host of rewards for the individual amateur. And these benefits can become all the more enjoyable because they serve others as well. Let's illustrate.

As a participant in amateur space activities, as a user of amateur radio satellites, especially AO-10, as a contributor to publications such as *Orbit*, and as a member of AMSAT, the amateur advances the ideals of amateur radio. Moreover, the opportunities for using a satellite productively have increased manifold with the launch of AO-10; satellite technology has been pushed forward too. AO-10 virtually bursts with public service potential, we believe!

As the individual amateur becomes familiar with AO-10, he or she will find features that have not been experienced before. Because of its lengthy access times, AO-10 will be a convenient meeting place for nets, both public service and special interest. Also, the satellite has superb capabilities for transmission of data; perhaps detailed medical information for a doctor struggling with a life-or-death case deep in the African bush. Or how about errorless Amateur Radio Bulletins, delivered and printed quickly. Perhaps a radiogram sent through AO-10 will bring words of comfort to anxious relatives from a disaster-struck village overseas. All that has made amateur radio a shining example of what public service means can be enhanced by the new OSCAR.

Does traffic-handling sound new to you? Or is public service a new concept? Of course not. Many relish the opportunity to help in these ways and many others participate in classes to bring young people in touch with our hobby and public service activities. Those too are an important part of AO-10's future because the bird will inspire and educate all of us, but especially the young people who will look up, marvel, and contemplate all that Space holds in store for us.

What does this have to do with personal commitment? Plenty. It means we can continue to pursue our hobby and public service as in the past but with some new and satisfying twists. By our productive use of AO-10, by doing those very things that we find most enjoyable about amateur radio, we will be affirming our continued support for the amateur space program and its future. Use and enjoy the satellite, and show the world that amateur radio satellites are here to stay. By our productive use of the satellite and all its advanced features we can commit ourselves to the great adventure started more than 20 years ago by OSCAR 1.

Tracking Phase III Type Satellites with the Satellipse

By K. J. Deskur, K2ZRO

The inventor of the famous Satellabe describes a new tracker for elliptical orbits.

A simple tracking aid, similar to the OSCAR locators familiar to Phase II users, will help Phase III users keep track of Amateur Radio's newest satellite — AMSAT-OSCAR 10. The device determines the position of the satellite with respect to the user's location in terms of azimuth and elevation as a function of real time.

During the past decade, many articles have been published on the subject of tracking aids, especially for application to Phase II satellites traveling in nearly circular orbits; the OSCAR and RS series for example. The usual tracking methods ranged from sophisticated, computer-generated tables and graphics to simple "dead reckoning" instructions. But probably the most popular tracking devices were the Satellabe, the OSCAR Locator, and W2GFF's OSCAR Plotter, simply because they were easy to construct and use and were sufficiently accurate for most practical purposes.

A similar tracking plotter can track Phase III satellites traveling in elliptical orbits and is equally easy to use by those familiar with the fundamentals of this method of satellite tracking.

Briefly, the satellite tracking plotter consists of three parts.

1. A polar projection map of the earth (or a polar graph) called the plotting board.

2. A normalized rotary ground-track/slider, pivoted at the pole with time-marks distributed along its length. If the origin of the track (as indicated by a cursor) is positioned on the longitude of an established reference point for the desired orbit (i.e. the equatorial crossing), the track will trace the path of the subsatellite points during the orbit in terms of the time-into-orbit beginning at the moment the satellite passed that orbital reference point.

3. The overlay consisting of a family or range-circles that are centered on the location of the tracking station. Each circle represents the locus of points equidistant from the station. The overlay, which is also divided into azimuth sectors, helps determine the bearing and elevation of the satellite with respect to the tracking station. It also helps estimate the duration of periods when the satellite is within communications range.

Although the tracking plotter for both Phase II and III are identical in principle, there are some structural differences between them.

The Plotting Board

A typical polar projection map for a Phase II plotter is usually extended no further than 30° beyond the equator. However, since the communications range of Phase III satellites covers almost an entire hemisphere, the map covers an area extending 50° to 60° beyond the equator (i.e. the Northern projection map should include the area up to -60° latitude — south).

The Earth Track

Because circular-orbit satellites orbit at nearly constant altitude and uniform velocity, the Phase II earth track looks like a bow that is partitioned with uniformly spaced time-marks.

The shape of the earth-track of an elliptical-orbit satellite is much more complex. It may be shaped like a hairpin, a resonance curve, or it may contain loops (Fig. 1). The shape of the track depends on the orbital parameters including the period, altitude at apogee and perigee, eccentricity of the orbit, angle of inclination, and the argument of perigee. Unless the inclination of the orbit is very close to 63.4° , the last parameter changes slightly with each consecutive pass. That in turn

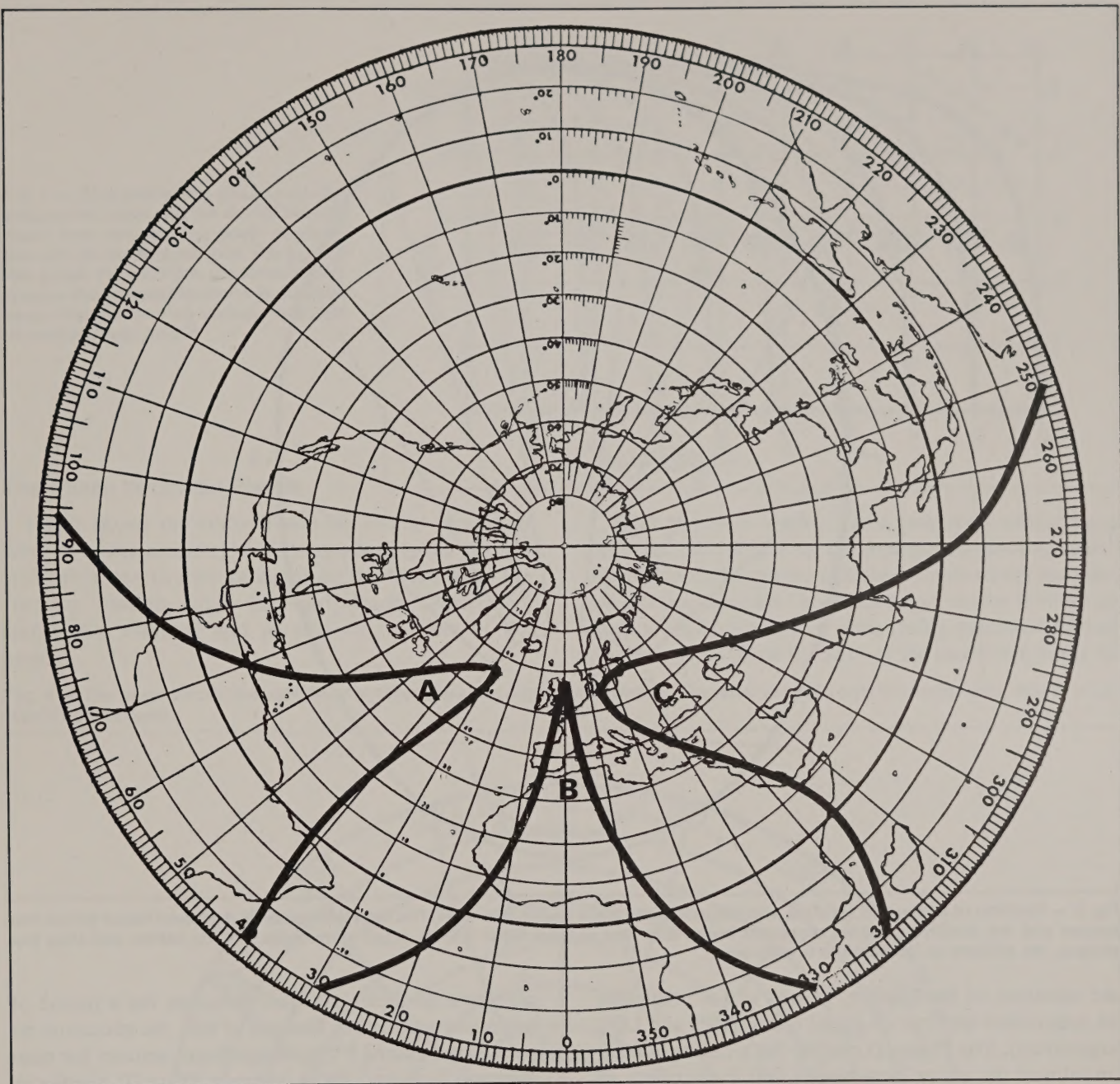


Fig. 1 — The shapes of the earth track of a Phase III satellite for three different values of the argument of perigee.

affects the shape of the earth-track. Consequently, the track must be redrawn every few weeks. Although the method for deriving the track is quite complex, the coordinates of a normalized track for different values of the argument of perigee will be available in various AM-SAT publications. In actual practice, for an orbital inclination of 57° , the tracking error will become significant only after four to six weeks.

Time-into-Orbit Marks

Because the velocity of a satellite in elliptical orbit is not constant, the time-marks superimposed on the earth-track will not be uniformly spaced. In fact, they will be compressed near the apogee when the velocity of the satellite is low and will spread near perigee when velocity is high. The time-into-orbit of Phase II satellites

is measured from the moment the spacecraft crosses the equator. However, for elliptical-orbit satellites it is more practical to use the time of apogee as a reference point and mark the time in terms of time-before and time-after the instant apogee was reached. [Ed. Note: Perigee could also be used.] That is because at equal intervals of time on either side of the moment of apogee, the altitude of the satellite is also equal (Fig. 2). As will be shown later, this simplifies the determination of the elevation angle to the satellite as viewed from the location of the tracking station.

The Overlay

The overlay for the Phase III tracking plotter is essentially similar to its Phase II predecessor and is used for the same purposes, namely, determining the azimuth

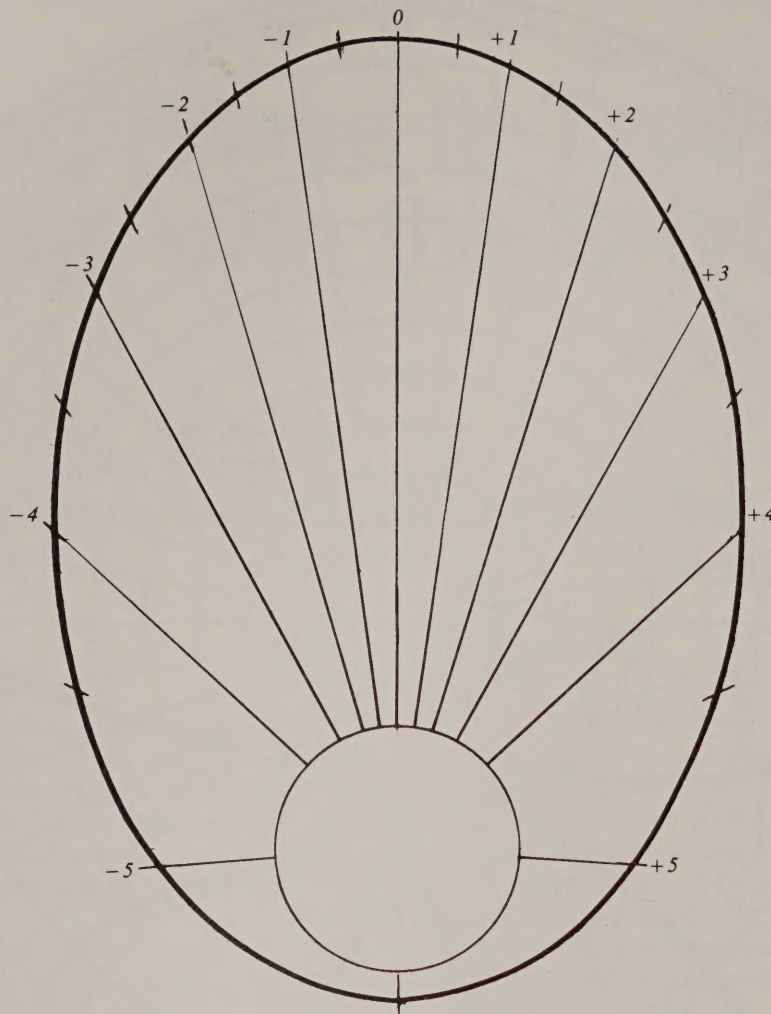


Fig. 2 — Position of a Phase III satellite with respect to the earth during one orbit. The negative numbers represent hours before the apogee and the positive numbers represent hours after the apogee. Note that at equal increments of time before and after the apogee, the altitude of the satellite is also equal.

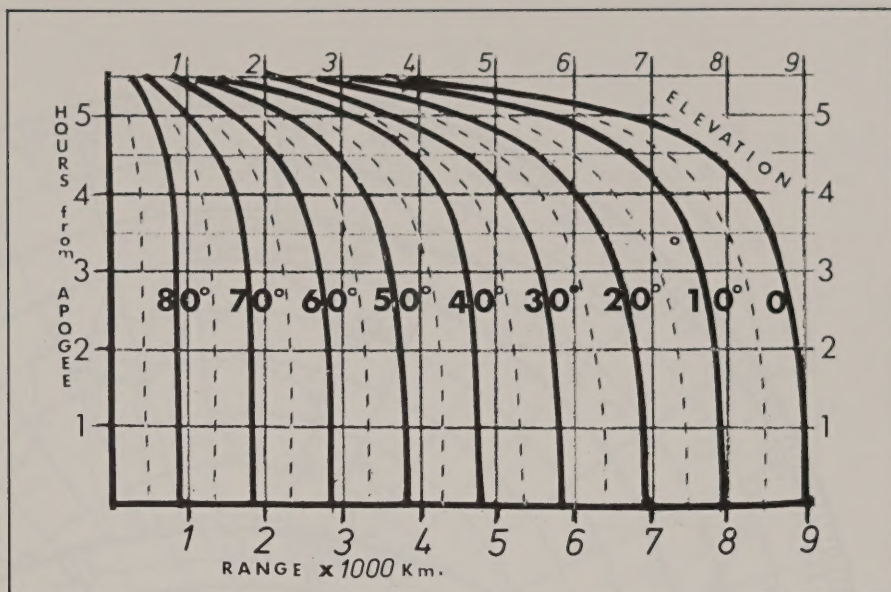
and elevation of the satellite, as well as for predicting the acquisition and loss of signal times (AOS and LOS respectively). The Phase III overlay has a radius of 9000 km (almost the entire hemisphere) that corresponds to the maximum communication range possible when the satellite is at apogee. Phase II satellites travelled at essentially constant altitudes. Therefore each of the equidistant range-circles were calibrated in degree of elevation rather than actual distance. This relationship no longer applies to elliptical-orbit satellites because of the large difference between the altitudes at the apogee and perigee of the orbit.

The range-circles of the Phase III overlay are drawn with equal increments of distance — in this case 1000 km — and with the exact elevation angle determined from the graph shown in Fig. 3. By examining this graph it is apparent that for an orbital time of between 0 and ± 3.5 hours (from apogee), the angle of elevation at a particular distance between the observer and the sub-satellite point does not change significantly with the altitude of the satellite. Consequently, the range-circles

can serve as circles of equal elevation for a period of seven hours per orbit. Because of this, the maximum error will not exceed 5° ; an insignificant amount for most practical purposes. Fig. 4 depicts a Phase III overlay on which the range-circles are calibrated for both the distance and the angle of elevation. The latter is valid only for a period of ± 3.5 hours from apogee time. This simple way to determine the angle of elevation can only be used if the time of apogee is established as a reference point of the orbit. If the time-into-orbit is counted from the time of perigee or the equatorial crossing, the calculation of the angle of elevation would be much more complex, particularly if continuous precession of the argument of perigee is anticipated.

It is important to remember that the shape of the overlay will be different for different latitudes of the tracking station. At the pole, the overlay will look like a perfect circle, and at the equator like a long ellipse. Coordinates of overlays for different latitudes at increments of 10° will be published in a future issue of *Orbit*.

Fig. 3 — By knowing the distance to the subsatellite point and the orbital time (in hours from perigee) the angle of elevation can be determined with the help of this graph. For example, if 4.5 hours after apogee the subsatellite point is 2500 km away from the tracking station, the angle of elevation will be 55°

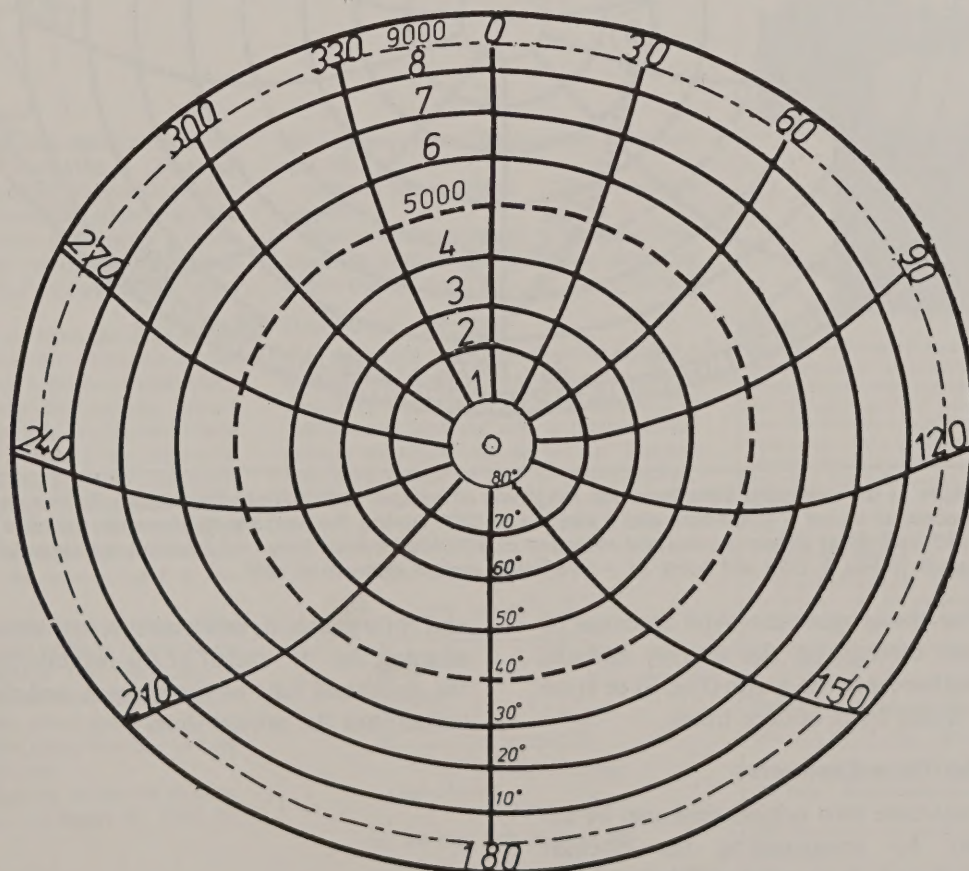


The Phase III Orbital Plotter

Fig. 5 shows the entire Phase III orbital plotter. It consists of three parts: the plotting board (polar projection map), the overlay centered on the location of the tracking station, and the earth-track, drawn on transparent material and pivoted on the pole of the map.

Here is how it works. From published orbital data draw the earth-track on the transparent pivoting scale. Include the time-marks and the latitude-of-apogee cursor. Rotate the scale to set the cursor on the latitude of the apogee of the desired orbit (using published orbital predictions). Follow the path of the satellite in terms of

Fig. 4 — The range circles are calibrated in kilometers and angles of elevation. The latter are valid only for orbital time, that is ± 3.5 hours from apogee.



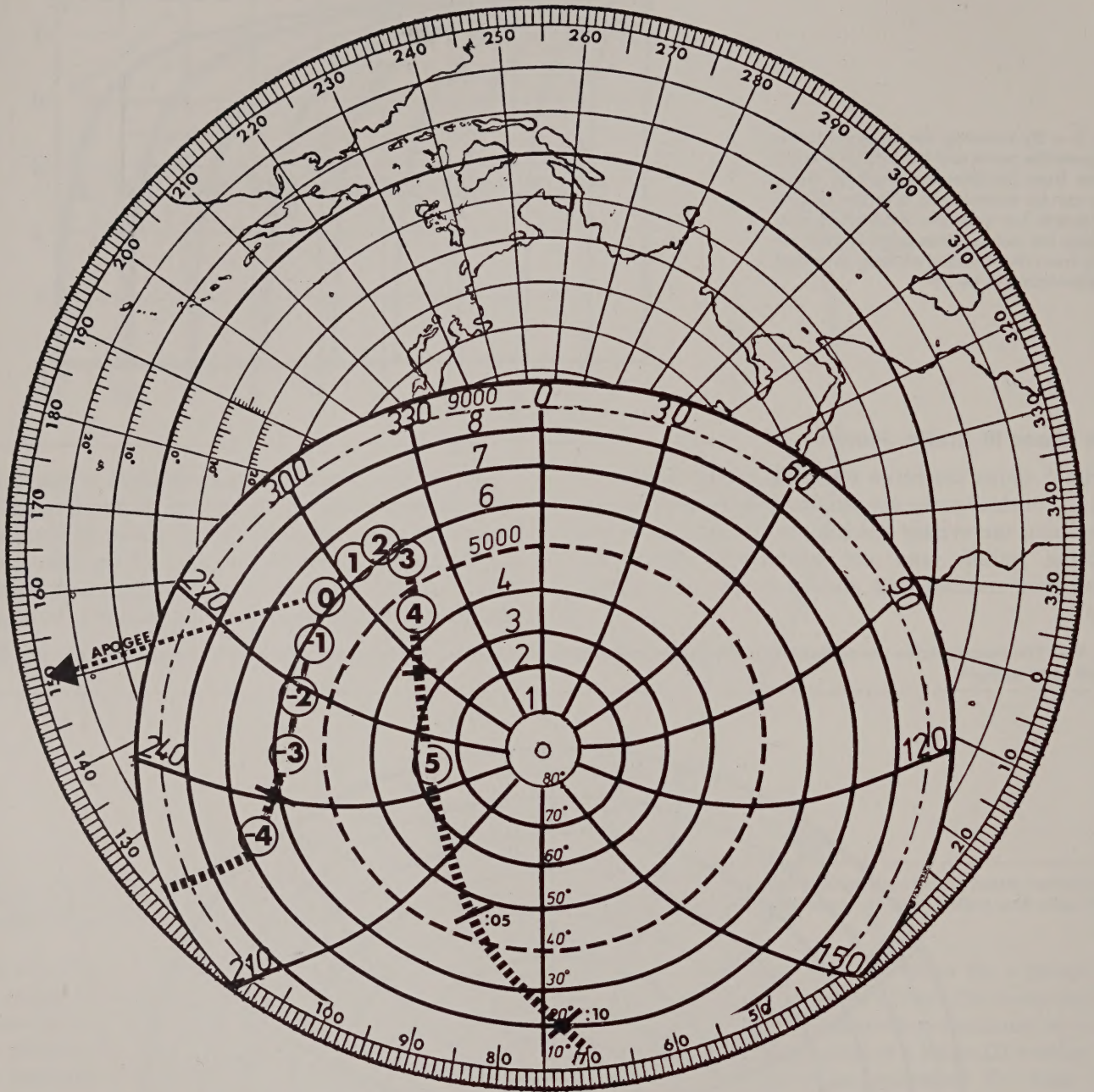


Fig. 5 — In this example of the complete *Satellite*, the longitude of apogee is 151° (note the cursor). Following the Earth Track shows that AOS will occur at about -4:30 hours and a bearing of 230°. During the next seven hours the satellite will traverse the azimuth angle from 240° to 315° at almost a constant elevation of 30°. After orbital time (+3.5 hours) the elevation will have to be estimated from the graph in Fig. 3. LOS will occur at -5:05 hours and an azimuth of 195°.

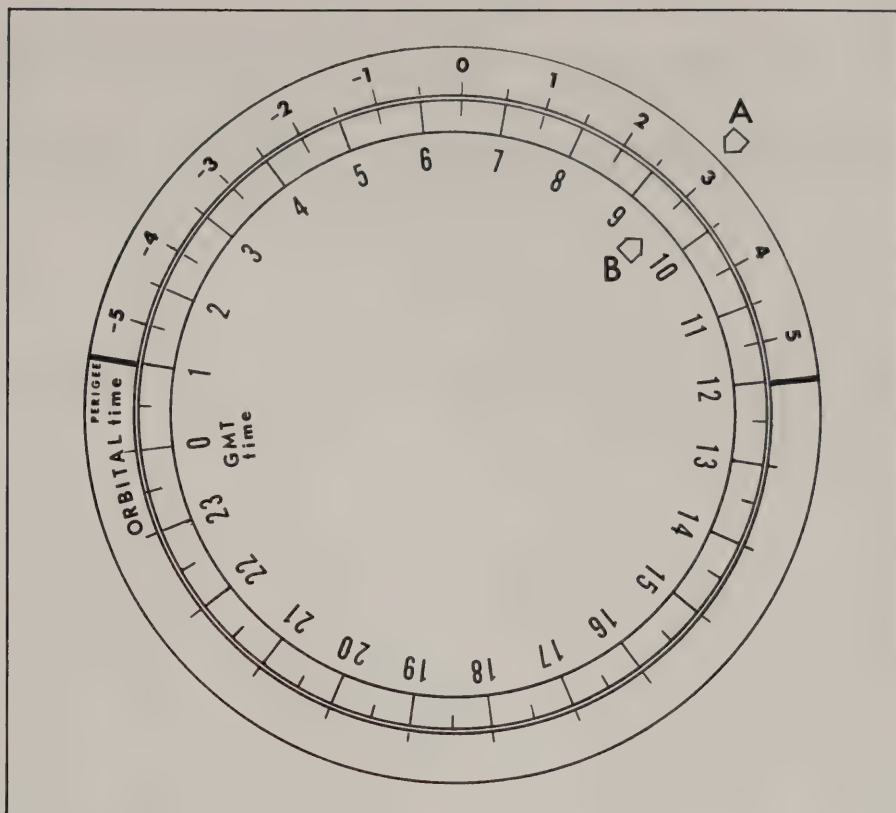
time before and after the apogee time. Aim antennas by reading the azimuth directly on the overlay and the angle of elevation either from the graph (Fig. 3) or from the overlay (± 3.5 hours from apogee time).

Real-Time to Orbit-Time Converter

Conversion of real-time into orbital-time can be accomplished simply by constructing the circular calculator shown in Fig. 6. It consists of fixed scale A, calibrated in terms of hours before and after apogee,

and rotary scale B, calibrated in real-time (24 hours). By aligning the "0" (zero) of the orbital-time scale against the published time of the apogee, real-time can be converted into the orbital time.

Fig. 6 — To use this real-time to orbital-time converter, rotate scales to set "0" of the Orbital-Time on scale A against the time of apogee (real time) on scale B. Read orbital time on scale A opposite the real time on scale B. Example: Time of apogee = 0630 UTC. Set "0" on scale A against 0630 on scale B. Read 0130 UTC = -5 hours of orbital time; 0400 UTC = -2:30; 0830 UTC = +2 hours, etc.



Letters

Dear Editor:

I would like to pass on a means of retaining information from my AMS-81 Tracking System. I am not fond of the Sinclair printer so first I thought of building an interface for my Epson printer. Then I thought of a much simpler way that was readily available to me. I output the Z-81 R.F. output to my video recorder.

I first ran the R.F. from the Z-81 to the recorder which gives fair definition of the data on the TV. Then I fed the straight video from the recorder to a video monitor instead of the TV. This improved the picture. I have a video tap on my Z-81 so I ran this to the video in on the recorder but didn't see much change. However, a one transistor amp might make a difference. I don't believe there is enough drive or an impedance mismatch from the Z-81 to the camera input to the recorder.

Many months of data can be stored on one tape. You can also dub audio in on the passes or any other comments. This could also be used to demonstrate the satellite and the software at hamfests or other meetings. I also find it a neat way for those who like to keep records of the orbits, etc.

I thought this might be of interest to other AMSAT members. — Charles W. Cox, Sr. KA5QNO

Dear Editor:

Today I received ASR No. 57 and I noted

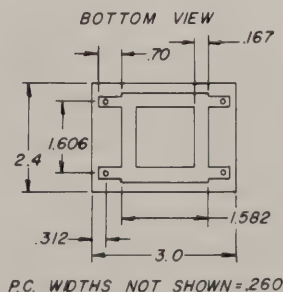
the L-transponder frequency not being correct. SRI.

Mode L: Input 1269.05 - 1269.85 would be correct.

This error also occurred in the latest *Orbit* magazine, in the frequency listing; statements within the text are o.k. — W. Haas, DJ5KQ

Dear Editor:

In my article "A Simple Dish for Mode L" in *Orbit* #13, there is a drafting error in Fig. 3 describing the 1270 MHz quad hybrid. The .260 dimension should refer to the horizontal arms of the hybrid, not the vertical. The vertical arms should be .167. — John DuBois, W1HDX



The non-profit World Space Foundation is leading development of an advanced space transportation technology in cooperation with the University of Utah and the Jet Propulsion Laboratory, with assistance from the Charles A. Lindbergh Fund.

Help support the World Space Foundation by purchasing one or more of our Official Solar Sail Project T-Shirts, which includes our no-cost information package.

☐ Please send me your no-cost, no-obligation information package.

☐ I have enclosed \$_____ for _____ T-shirts, which also includes our no-cost information package, no-obligation

Top quality hand silkscreened 50/50 T-shirts, dark blue with white logo.

\$8.00 each (2 for \$14.00) Calif. res. add 6% sales tax. Please indicate size and style of T-shirts desired.

Size: ☐ S ☐ M ☐ L ☐ XL Style: adult ☐ A ☐ C child

Solar Sail Project/World Space Foundation
P.O. Box Y, South Pasadena, Calif. 91030

Name _____

Address _____

City _____

State _____

Zip _____

©1981 World Space Foundation

The Phase III IFDEM PSK Telemetry Beacon Demodulator Part II*

By John DuBois, W1HDX

The OSCAR-10 Command Chief describes the circuit and function to extract data and clock information from the PSK signals.

Following the PSK demodulator, the Phase III telemetry signal from the engineering beacon must be processed to separate data and clock waveforms. They have been combined by bi-phase modulation so that both can be transmitted on the same channel. The simplest way to visualize the combining process is to think of the clock as being transmitted unchanged during binary data zeros and transmitted with opposite polarity (a 180° phase shift) during binary data ones. The signals are easy to decode if an accurate replica of the clock is available at the receiving point.

The main task of the bit regenerator (see Figure) therefore is to obtain a noise-free and stable a clock from the PSK demodulator output. Decoding and filtering of the data is relatively easy once the clock has been extracted. First, hard limiting must be performed on the incoming signal by toggling a comparator at zero crossings of the signal. The signal is filtered by an RC bandpass filter and then sent to the inverting input of comparator IC-A1. The output of that device switches between ground and +10 V on zero crossings of the input signal and contains no amplitude noise. Any uncertainty or noise will be created at the time of the output transitions.

The task is to recognize and extract that part of the waveform that is solely related to the clock. The bi-phase modulation process (Fig. 1) has the effect of deleting some of the transitions from the output that were present in the clock. If a flip flop was triggered at the edges of this signal to reconstruct the clock it would be in error at these missing transitions. In fact if the 400 Hz clock is considered as a carrier and the binary data as its modulation, the bi-phase modulation process has largely suppressed the carrier, leaving only sidebands in the output. Although some carrier or clock remains during periods of sequential zeros or ones, it frequently changes phase by 180° . These phase changes preclude a simple extraction because they would completely upset signal lock.

The present problem of clock extraction from the bi-phase modulated data signal is in fact analogous to that

of carrier recovery from a $\pm 90^\circ$ PSK radio-frequency signal. The discussion in the earlier article (*Orbit 5*) regarding methods also applies to bi-phase clock recovery. In this case, however, the signal-to-noise ratio is better and a technique of frequency doubling the incoming signal to obtain an unambiguous double clock frequency can be made to work well.

The incoming bi-phase signal is frequency doubled so that phase changes which were 180° will be 0 or 360° values that do not change the phase of the output wave. Doubling is accomplished in the bit regenerator by feeding the signal, both directly and delayed about 150 microseconds into two inputs of an exclusive-OR gate, IC-C1. This creates an output pulse, on both the rising and falling edges, that contains a broad spectrum at multiples of the 400-Hz repetition rate. The large amplitude component present at twice the clock rate, 800 Hz, is extracted by an active RC bandpass filter amplifier, IC-B1. The Q of this stage easily rejects nearby 400-Hz and 1200-Hz components of the input spectrum. The output of IC-B1 is converted to a square wave by comparator IC-A2, which triggers on zero crossing of the 800-Hz signal.

The next job is to lock onto the 800-Hz square wave with a phase-locked loop (PLL) that has a long enough time constant to keep small phase changes due to noise from significantly affecting its output. The PLL output is then divided by 2 to obtain a reconstructed clock that does not have modulating data. The PLL consists of an

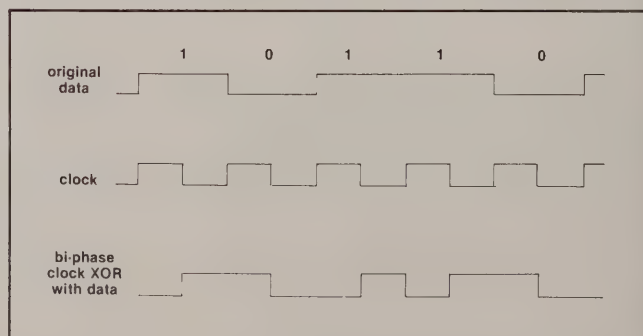
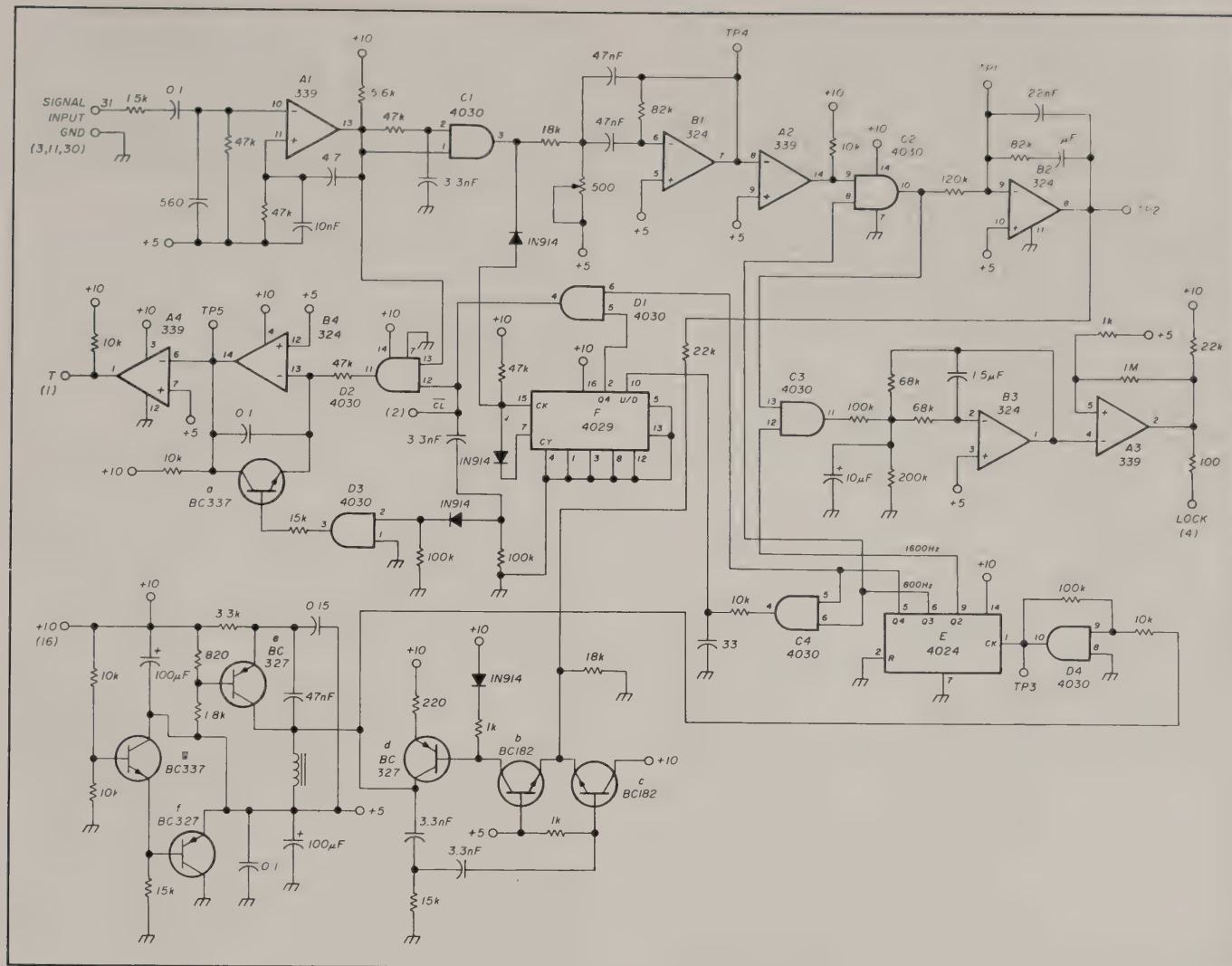


Fig. 1



Circuit diagram for the W1HDX demodulator.

XOR gate (IC-C2) that acts as a phase detector, an operational amplifier (IC-B2) that acts as the loop filter, a Colpitts oscillator and reactance modulator, formed by transistors b-e, which make up the loop VCO, and finally counter IC-E, which acts as a frequency divider. The VCO operates at 12.8 kHz to achieve good voltage sensitivity. It's output is divided to 800 Hz by IC-E before being connected to the phase detector.

The loop filter has a low-pass characteristic with a cutoff frequency of 4 Hz and a 12 dB/octave slope. This rejects noise perturbations of the loop above the cutoff frequency to provide a stable clock output. The output from the PLL is taken from IC-E at 800 Hz for the loop phase detector and at 40 Hz for the actual clock.

There is an equal probability that the clock regenerated by the PLL will have one of two phases 180° apart. This is a direct result of the bi-phase encoding that was used to carry clock information along with the data. An ambiguity exists because the transmission that results from a long string of ones is indistinguishable from that of a long string of zeros. Although one sequence started 180° before the other, it is not possible to tell whether they are ones or zeros.

Fortunately there is a way to resolve the ambiguity as long as real data is being sent. If there are transitions between one and zero in the data and periods of the same logic state are not very long, it is possible to determine which polarity the received signal should have. The relation between a binary data stream and its bi-phase encoded function shows that the bi-phase output does not change at transitions of the original data stream except when there is a sequence of two or more data bits of the same logic sense.

This can be seen in the middle of the two sequential data 1's in Fig. 1 and can be used to establish which polarity of the regenerated clock waveform matches the original relationship between clock and data.

It is important to examine the incoming bi-phase data stream with respect to the regenerated clock to see if more transitions are occurring in the centers or at the boundaries of the data bit cells. (The data bit cell center is defined by positive transitions of the regenerated clock.) If more bi-phase signal transitions are occurring at the edge of data bit cells as compared to the center then the regenerated clock is upside down and must be inverted.

In order to make this test, output pulses from IC-C1 are fed to the count input of an up-down counter, IC-F. These pulses always occur at the edges or transitions of the incoming bi-phase wave. The up-down control input is fed a waveform, derived from IC-E and IC-C4, which has the same frequency as the clock but leads it by 90°. When the clock is high, representing the center of data bit cells, IC-F counts down at transitions of the incoming bi-phase signal. When the clock is low, representing edges of data bit cells, IC-F counts up at these transitions. Therefore if there are more incoming bi-phase transitions at the center of data bit cells (clock high) the up-down counter will stay at or near zero. Conversely if the majority of transitions occur at the edges of data bit cells (clock low) then the counter will stay at or near its maximum count. The counter has been connected so that it will not count below zero or above 16.

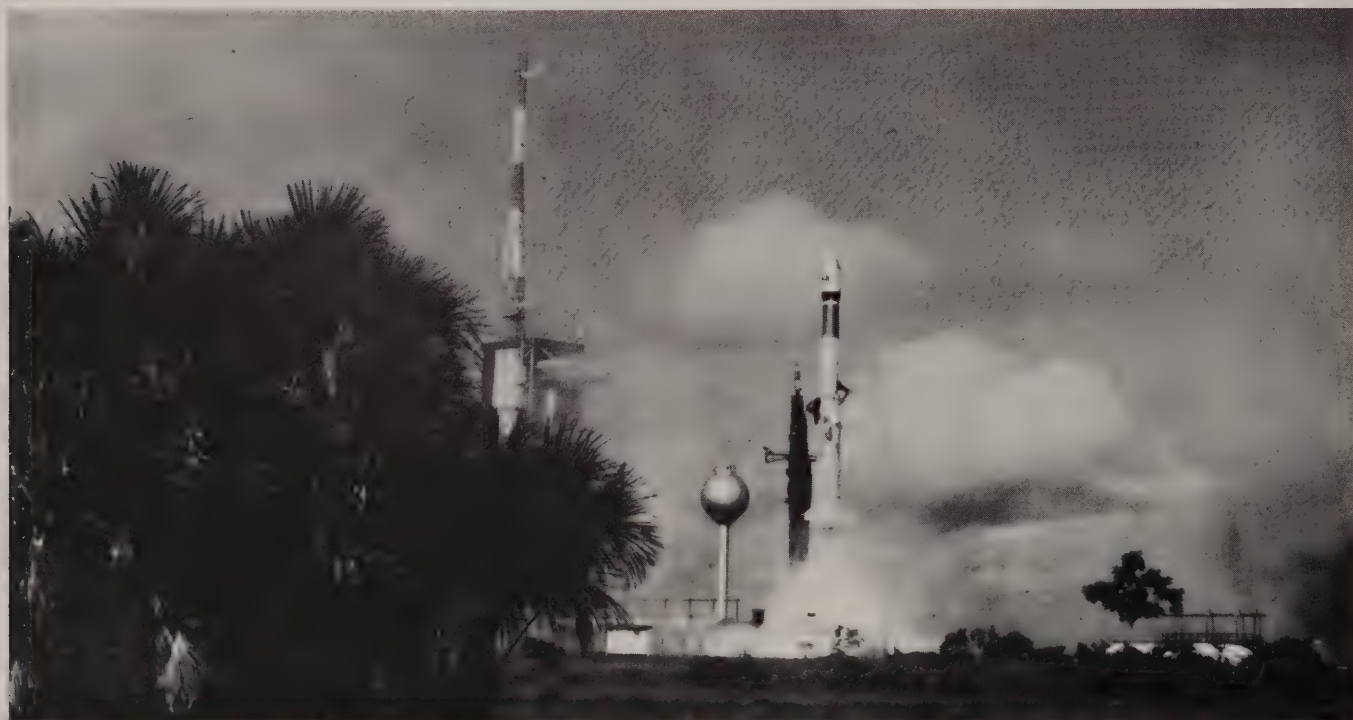
The output of the counter can be used to correct the ambiguity existing in the derived clock. If it has counted to 16 it is necessary to invert the clock. The clock is connected to one input of XOR gate IC-D1 and the counter Q4 output to the other XOR input. If the Q4 output is low the clock passes through this gate unchanged but if Q4 is high, signifying an upside down clock, the gate inverts it to the correct polarity.

The clock waveform is now available at the output of the IC-D1. Its first job is to separate data from the clock in the incoming bi-phase signal. The clock is connected to one input of XOR gate IC-D2 and the bi-phase signal to the other input. The decoded output represents the original data, as it was before bi-phase encoding. If the signal has been transmitted over a noisy channel, however, the reconstructed data will be contaminated by noise. Various filters or averaging schemes may be

devised to reduce this noise but the best method, when dealing with binary data and random additive Gaussian noise, is to integrate the data plus noise signal over a period of one bit length and decide at the end of this period whether the signal plus noise exceeds a reference level. If it does, then it is assumed that a binary one has been received; if not, a binary zero.

The integrator is then reset and the process begins again for the next bit period. The sequence of integration decision and dump is carried out by IC-B4, IC-D3, and IC-A4. The noisy data signal is connected to IC-B4 which is an operational integrator. It will integrate up toward +10 for a high logic level out of IC-D2 and down toward ground for a low logic level.

The clock signal is differentiated and connected to IC-D3 to provide reset pulses for the integrator reset switch once per bit period. This reset timing will be contaminated by far less channel noise than the data because of the long time constant of the PLL which is regenerating the clock. The actual reset is accomplished by transistor A which shorts out the integration capacitor when pulsed by IC-D3. This returns the integrator output to a +5-V reference level. Comparator IC-A4 makes the decision. One input is connected to the reference and the other input receives the integrator output. Immediately after reset this input is at +5 V and the comparator output can flip either way. The integrated signal plus noise over the next bit period will force this level up or down toward the best guess at whether the signal before noise was a zero or a one. Comparator IC-A4's output then is the final data signal that is fed, along with the recovered clock from IC-D1, for processing by a computer.



Ariane L6 with Phase IIIB and ECS-1 aboard head skyward about T + 6 seconds, 11:59:09 UTC, 16 June, 1983.

AMS-81 Project Status

By Ralph Wallio, WØRPK

A simple and inexpensive way to automate your AO-10 tracking chores is explained by the Project Manager.

The AMSAT AMS-81 TRACKING SYSTEM (software version) is ready for distribution! This article outlines its capabilities and operation. It also provides ordering information.

The AMSAT AMS-81 TRACKING SYSTEM has been designed to provide owners of inexpensive Sinclair ZX-81/Timex Sinclair 1000 computer systems (16K RAM) with accurate schedule and tracking information for satellites in Phase II or III type orbits. Input data to this system includes Keplerian orbital elements (available through AMSAT and NASA) for up to 14 spacecraft, station latitude, longitude and height coordinates.

The ZX-81/TS-1000 and video display are set up as integral parts of the satellite operating position such that operators are able to manipulate the keyboard easily and see the display without turning far from other equipment.

The AMS-81 program load takes about 7-minutes. The initial menu, Fig. 1, appears if the load is successful. An activity is selected by entering the appropriate number (1-5).

The SCHEDULING activity allows the operator to determine in advance when a given satellite will be above the horizon and provides other pertinent data about each pass. The activity menu, Fig. 2, allows the selection of the desired satellite (A-N) and requires input of the starting EPOCH. The computer calculates scheduling information in FAST mode (which means the display is blank) and stops when the display is full (20-60 minutes later).

SCHEDULING information, Fig. 3, includes one line of data for each "pass" starting from the access period in progress or the next one to occur after the starting EPOCH. Each access period contains the date, AOS,

LOS and MAX times (UTC), with a parameter and azimuth associated with MAX time. The date refers to AOS with LOS possibly occurring on the following day. If LOS occurs more than one day after AOS it is so indicated.

The DX/EL data is associated with MAX time and is either the maximum DX distance (measured along the surface of the earth in kilometers) available during a Phase III pass or the maximum elevation achieved with Phase II type orbits. Maximum range on Phase III type orbits will occur at apogee, if apogee is in view of the station, or at AOS or LOS if apogee is not in view (indicated by an asterisk following data). Phase II maximum elevations will include an "EL" for identification. The AZ (azimuth) column gives the direction in which the maximum range or maximum elevation occur.

The AMS-81 TRACKING activity gives the operator times coordinates for aiming a steerable antenna array. Satellite selection and EPOCH input are the same as

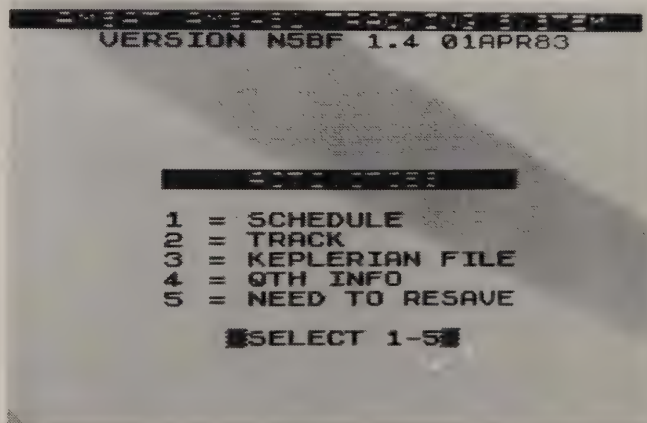


Fig. 1

```

AMSAT AMS-81 TRACKING SYSTEM
*** TRACKING ACTIVITY ***

A = P3B INITIAL
B = P3B FINAL
C = A08
D = U09
E = R55
F = R56
G = R57
H = R58
I = A07
J = SRET-2
K = R53
L = R54
M = VACANT
N = VACANT

■SELECT A-N (RETURN=0)■

```

Fig. 2

with the SCHEDULING activity. However calculations are done in SLOW mode so that data can be seen (and used). TRACKING starts from the starting EPOCH if a pass is in progress otherwise it starts from the next AOS.

Each line of TRACKING output, Fig. 4, contains the time (HHMM:SS), azimuth (AZ), elevation (EL), slant range, orbit phase (0-255) for Phase III spacecraft and an average Doppler shift for the last calculation interval. Successive lines of data are displayed when azimuth or elevation changes of between eight and ten degrees are required except at high elevations when AZ might change as much as 27 degrees between displays (only a few degrees of vector change).

A full display of tracking data is followed by an input request of RETURN=0, CONTINUE=1, SCROLL=2 or STEP=7. Phase II operation works best with the SCROLL option by entering [2] at the beginning of the pass. Phase III operation works best with the STEP option by entering [7] as required to generate additional lines of tracking data (READY indicates data is available).

The KEPLERIAN FILE maintains data on as many as 14 different spacecraft that can be viewed or modified as desired. The KEPLERIAN FILE activity menu allows the selection of a given satellite (A-N) after which individual data items are displayed as follows, Fig. 5,:

NAME	(Free form - limit to 9 characters)	) OSCAR 8
ID	(Free form - limit to 12 characters)	) NASA SET 729
EPOCH	(Enter in correct format)	) 01FEB83 121035
INCL	(Inclination in degrees)	) 98.7625
RAAN	(Right ascension of ascending node in degrees)	) 51.6802
ECCE	(Eccentricity value between 0.0 and 1.0)	) .0006486
ARGP	(Argument of perigee in degrees)	) 349.8875
M.A.	(Mean anomaly in degrees)	) 10.2178
M.M.	(Mean motion in orbits per day [1])	) 13.9654
DRAQ	(Atmospheric drag in orbits per day per day)	) 1.55E-6
FREQ	(Frequency in MHz for Doppler calculations [2])	) 435.095

[1] Semi-major axis in kilometers may be substituted for Mean motion

[2] Use transponder conversion or beacon frequency

```

AMSAT AMS-81 TRACKING SYSTEM
ACCESS SKED FROM: 03JUN83 121500
>>W0RPK VIA P3B INIT <<
DAY AOS LOS MAX DX/EL AZ
03JUN 2307 0859 0403 14543 158
04JUN 2251 0548 0108 16809 112
06JUN 0420 1353 0847 16708 247
07JUN 0103 1055 0552 14458 201
07JUN 2201 0751 0258 15077 140
08JUN 2323 0431 0004 17640 102
09JUN 0715 0925 0925 18031* 261
10JUN 0305 1248 0742 15837 235
10JUN 2354 0948 0448 14196 180
11JUN 2101 0641 0153 15813 125
12JUN 2351 0305 2351 18066* 095
13JUN 0523 1034 0932 17616 259
14JUN 0153 1142 0637 15015 221
14JUN 2247 0840 0343 14352 159
15JUN 2204 0529 0049 16625 112
■ RETURN = 0, CONT = 1 ■

```

Fig. 3

The QTH FILE maintains station coordinates for scheduling and tracking calculations. Individual parameters are viewed and changed in the same manner as in the KEPLERIAN FILE described above. File contents include, Fig. 6,:

CALL	(Limited to 10-characters)	) W0RPK
LAT N	(Latitude in decimal degrees [1])	) 41.4375
LON W	(Longitude in decimal degrees [1])	) 93.5625
HT M	(Height above sea level in meters)	) 221

[1] Southern latitudes or eastern longitudes are entered as negative numbers.

The RESAVE activity is available anytime KEPLERIAN FILE or QTH FILE data is changed. The original AMS-81 tape contains KEPLERIAN FILE data for late March, 1983 and sample QTH FILE data. This tape should be set aside for future use after the initial load. After the latest KEPLERIAN data and correct QTH data are entered, the RESAVE activity should be used to create an up-to-date copy of the program and important data.

The system periodically scans the [SLOW], [FAST] and [STOP] keys while in SCHEDULING and TRACKING activities to give operator control. Hold the appropriate key down for several seconds to change modes.

```

AMSAT AMS-81 TRACKING SYSTEM
TRACKING FROM 03JUN83 121500
>>W0RPK VIA P3B INIT <<
UTC AZ EL RANGE PH5 DOPPLER
2307:15 194 00 7785 8 145.812
2309:28 188 03 8180 9 -1.4
2311:42 184 06 8623 10 -1.6
2313:56 179 08 9101 10 -1.7
2316:50 174 10 9756 12 -1.8
2319:44 170 12 10434 13 -1.9
2323:44 165 13 11388 14 -1.9
2328:46 160 15 12585 16 -1.9
2335:17 155 17 14104 19 -1.9
2344:11 150 18 16087 23 -1.8
2357:28 145 19 18818 28 -1.7
-----04JUN83-----
0021:04 140 22 23017 38 -1.4
0121:05 139 27 30753 62 -1.0
0221:06 144 32 35377 86 -0.6
0310:41 150 36 37374 106 -0.3
■RET=0 CONT=1 SCROLL=2 STEP=7■

```

Fig. 4

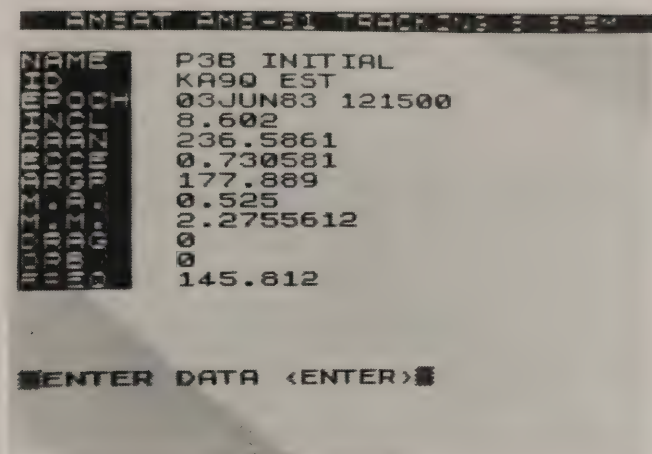


Fig. 5

There is a very minor chance that a combination of orbital elements and station location will yield the situation that no "passes" occur causing the AMS-81 system to continue searching indefinitely. Other situations may yield "passes" only infrequently in which case the search may take a very long time. These situations should not occur with Phase II or Phase III type orbits but are unpredictable with other missions such as the SPACE SHUTTLE.

This system should not be used for geosynchronous satellites or the Moon. AMSAT will have a ZX-81/TS-1000 Moon tracking program available via the software exchange in the near future. Many articles and simple programs are currently available for acquiring look angles for geosynchronous spacecraft.

The AMS-81 system may miss "passes" of extremely short duration due to the adjusted step search method employed. Operators interested in these grazing passes should reassign the value of the variable IN from the default value of 15 to something shorter such as 5. This will cause the system to catch "passes" of shorter duration but will increase processing time significantly. To revalue IN, return to the initial menu, hit [BREAK], enter [LET] [I] [N] [=] [5] [ENTER], then enter [GOTO] [0] [ENTER].

AMS-81 tracking calculation produces successive lines of data for azimuth or elevation changes of nine

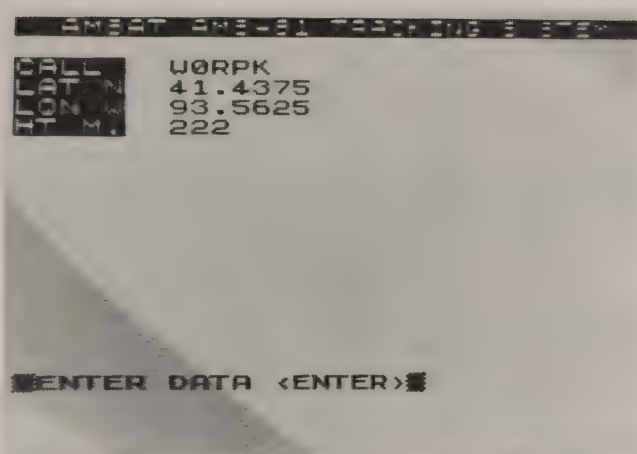


Fig. 6

degrees plus or minus 20%. This target can be changed by altering the value of the variable CA from nine to the desired value. To revalue CA, return to the main menu, hit [BREAK], enter [LET] [C] [A] [=] [new value] [ENTER], then enter [GOTO] [0] [ENTER].

Approximate station coordinates can be obtained from U.S. Geological survey maps, aeronautic charts, county extension engineers or local commercial radio stations. Keplerian orbital elements are available in AMSAT publications and on AMSAT nets for all active OSCAR spacecraft. Elements are available from NASA for these and other missions.

AMS-81 distribution will initially be separate from the AMSAT Software Exchange to accommodate the large numbers of orders anticipated. Please send checks or money orders made payable to AMSAT in the amount of \$15 (U.S.) to:

AMSAT AMS-81 TRACKING SYSTEM
c/o Bob McCaffrey, K0CY
3913 29th Street
Des Moines, IA 50310

The AMS-81 program was written by Courtney Duncan, N5BF. Basic mathematical and housekeeping methods were developed by Dr. Tom Clark, W3IWI, as described in *Orbit* magazine, issue 6. The AMS-81 project is managed by Ralph Wallio, W0RPK, and Doug Loughmiller, KO5I.

Comets

Winner of last year's "Chicken Little" contest, Buzz, W4BE, reports his new KLM 70 cm antenna is up and ready for Mode B. Buzz won the top prize in the contest, the KLM 420-450-18C (distributed by KJI Electronics) here seen between two 2m yagis.



AO-10 Ground Station Analysis

By Hasan Schiers, NØAN

Ever wonder how to calculate the noise figure of your system? Noise temperature? Here's how to go about it.

By using a series of equations and readily-obtained equipment performance figures, the prospective OSCAR-10 satellite user can determine not only how well he or she will hear the satellite, but also how well the spacecraft will hear the signals from the home station. The satellite enthusiast can easily determine the cost/benefit ratio of using a better preamplifier, for example, or perhaps using better coaxial cable to reduce feed line loss. What benefit can be realized by moving the preamplifier closer to the antenna or raising the transmitter power? The following information will help answer the questions and perhaps guide the radio amateur in making better choices in equipment for the ham shack.

Two analyses can be performed to first determine what signal levels can be expected from OSCAR-10's downlink transponder on 2 meters and what signal the satellite will be able to hear from the ground station. The intent is not to provide an in-depth analysis, but rather to give the variables that can be easily identified and to explain how they can be used to better evaluate existing or planned ground-station equipment. The analysis is for Mode B operation but the techniques can also be used for other transponders and satellites.

Variables Described

Several specific components must be known or be calculable in order to assess the downlink budget:

1. Transponder Output Power (14 W average)
2. Satellite Antenna Gain (2m) (6 dB)
3. Free Space Path Loss @ 146 MHz over a 38,000 km (– 168 dB) path
4. Multi-Use Power Sharing Factor (– 10 dB)
5. Propagation Loss (– 1 dB)
6. Antenna Pointing and Polarization Loss (– 2 dB)

7. Ground Station Rx Antenna Gain (+ 11 dB)
8. Ground Station Feedline Loss
9. Preceiver Preamplifier Noise Figure and Gain
10. Receiver (or multimode XCVR Noise Figure)

Once the above variables are identified or calculated, it is easy to predict the signal-to-noise ratio that OSCAR-10's downlink will present to a receiving station.

The following is typical:

1. Satellite 2 meter output power: This has been measured at 14 W average by AMSAT.
2. Satellite 2 meter apogee antenna gain: This has been specified at 6 dBc by AMSAT.
3. Free space path loss: This figure may be taken from the *RSGB VHF/UHF Handbook* (pp 9.5 and 9.11). For the purposes of the analysis, 146 MHz is specified as the frequency and 38,000 km (apogee height) as the distance. The resultant free space path loss is therefore 168 dB.
4. Multi-use power loading factor: This variable is the result of all users sharing the available transmitter power. It assumes a random distribution of instantaneous power drain based on cw and ssb signals. A factor of 10 dB is required for approximately 50 users with equal signal strength presented to the transponder's receiver. This figure is also found in the *RSGB VHF/UHF handbook* (p. 9.11).
5. Propagation loss: This is an assumed figure of 1 dB based upon the signal path not propagating in truly free space but rather through the earth/satellite medium of the atmosphere and ionosphere (RSGB).
6. Antenna pointing and polarization loss: A figure of – 2 dB is also based on information in the *RSGB VHF/UHF book* and is the result of antenna aiming error (none of us is perfect!) and shifts away from ideal

polarization compatibility.

7. Ground station 2m antenna gain: This figure is readily available from the antenna manufacturer. In the example we will use the KLM 16C which has a specified gain of 11 dBc.

8. Ground station 2m feedline loss: Assuming your preamplifier is located in the shack and not at the antenna feedpoint, this figure is simply obtained from the ARRL handbook based upon the type of feedline and its length. In the example, 1.5 dB is assumed based on 75 feet of type 8214 foam polyethylene coaxial cable.

9. Receive preamplifier noise figure and gain: This figure is readily available from the manufacturer. A typical example, the popular Janel QSA-5, shows 15 dB gain and a 2 dB noise figure.

10. 2 meter receiver (or multi-mode transceiver) noise figure: This parameter is not easily determined. No manufacturer supplies the noise figure for the front end of their radios. However, Amateurs who have measured a variety of radios have concluded they generally range from 3 dB at best to 8 dB at worst. For this analysis, assume 5 dB.

With all the particular variables that will be the source of the analysis identified, a method of finding each variable's contribution to our ability to hear must be determined. The method here chosen is found in the *RSGB VHF/UHF* handbook. All variables that comprise major sources of threshold sensitivity are converted to the common denominator of noise temperature. This parameter, (in °K) as well as noise figure (in dB), minimum discernable signal (in dBm, and sensitivity (in microvolts) are all measures of the weakest signal that can be heard in a receiving system. It is not possible to analyze the contribution of each of the above ten elements without choosing one measure of receiver threshold sensitivity. For the purposes of this analysis the variables will be converted to noise temperature and added together to arrive at a system noise temperature. Then they will be converted back to the more recognizable system (or effective) noise figure and minimum discernable signal (MDS).

Noise Contribution Of Each Element Described

The first variable that must be determined is the background noise level (or noise floor) of the sky at the frequency of interest (2m). Most sources agree that the background noise level on 2m amounts to a standing noise figure of 2 dB, i.e., in order to hear the noise level of the sky at 2m, a preamplifier mounted at the antenna would have to have a noise figure of 2 dB or less. Therefore, this 2 dB background noise figure must be converted to a sky noise temperature.

$$\begin{aligned}\text{Noise Temp.} &= [\text{Antilog}(0.1 \times \text{NF}) - 1] \times 290^\circ\text{K} \\ &= [(\text{Antilog } .2) - 1] \times 290^\circ\text{K} \\ &= (1.585 - 1) \times 290^\circ\text{K} = 169.6^\circ\text{K}\end{aligned}$$

The sky noise temperature is then 170°K.

The next variable for which noise temperature contribution must be determined is feedline loss. In the ex-

ample, assume a feedline loss of 1.5 dB, which corresponds to 75 feet of RG8/U foam coax. To calculate the noise temperature contribution of this loss, first convert 1.5 dB loss to its equivalent loss ratio:

$$\text{Loss Ratio} = 1.412$$

The equivalent sky temperature therefore is equal to the cold sky temperature of 170°K divided by the feedline loss ratio.

$$170^\circ\text{K}/1.412 = 120^\circ\text{K}$$

The equivalent feeder loss temperature is calculated as in the initial conversion from 2 dB sky noise figure to sky temperature.

$$\begin{aligned}\text{Noise Temp.} &= (\text{loss ratio} - 1) \times 290^\circ\text{K} \\ &= (1.412 - 1) \times 290^\circ\text{K} = 119.5^\circ\text{K}\end{aligned}$$

This must be reduced by the loss ratio of the line, 1.412, which yields a final figure of $119.5/1.412 = 84.6^\circ\text{K}$.

Next, analyze the noise contribution of the 2 dB noise figure of the 15-dB gain preamp.

$$2 \text{ dB NF expressed as a ratio} = 1.585$$

$$\text{Noise Temp} = (1.585 - 1) \times 290^\circ\text{K} = 170^\circ\text{K}$$

The coupling loss from our preamp to the multimode 2m transceiver is a result of the interconnection cables and RF connection. It is assumed to be 0.2 dB. Expressed as a ratio, this is 1.047.

$$\text{Noise Temp} = (1.047 - 1) \times 290^\circ\text{K} = 13.7^\circ\text{K}.$$

This must be reduced by the gain ratio of the preamp and since its gain is 15 dB, the gain ratio is:

$$\text{Antilog}(0.1 \times \text{dB gain})$$

$$\text{Antilog}(0.1 \times 15) = 31.6$$

Therefore, the noise contribution of our coupling loss is:

$$13.7^\circ\text{K}/31.6 = 0.43^\circ\text{K}$$

The combined noise temperature contribution of the preamp and 2-meter multimode transceiver must now be calculated.

It is already known that the 2m rig has a NF of 5 dB. Expressed as a ratio, $\text{Antilog } .1 \times \text{NF} = 3.16$

$$\text{Noise Temp} = (3.16 - 1) \times 290^\circ\text{K} = 627^\circ\text{K}$$

This figure must be reduced by the gain ratio of the preamp 31.6. Therefore, the noise contribution of the 2m multimode rigs front end is:

$$(5 \text{ dB NF}) \frac{627^\circ\text{K}}{31.6} = 19.8^\circ\text{K}$$

$$\begin{array}{ll}(\text{preamp} & 31.6 \\ \text{gain}) & \end{array}$$

Finally, to determine the system noise temperature:

Equivalent Sky Noise Temperature	120 °K
Equivalent Feeder Loss Noise Temp	84.6 °K
Preamp Coupling Loss Temp	0.43 °K
Preamplifier Noise Temp (2 dB NF)	170 °K
Noise Contribution of 2m XCVR	19.8 °K
System Noise Temperature	394.8 °K

At this point the receiver threshold sensitivity can be determined using the system noise temperature (T_s) and one equation:

$$P_n = 10 \log_{10} K T_s B$$

where:

$$P_n = \text{Receiver Threshold Sensitive in dBW}$$

K = Boltzman's constant 1.38×10^{-23} in joules per °K

B = Receiver bandwidth in Hz (3000 for ssb)

$P_n = 10 \log_{10} (1.38 \times 10^{-23}) (394.8) (3000)$
 $= -167.9 \text{ dBW or } -137.9 \text{ dBm}$

The system noise temperature (T_s) can also be used to calculate system noise figure (SNF)

$SNF = 10 \log_{10} (T_s/290 + 1) \text{ dB}$

$SNF = 10 \log_{10} (394.8/290 + 1) \text{ dB} = 3.73 \text{ dB}$

2M Signal Level Presented To The Receiver

Satellite Output Power 14 W Average +41.4 dBm

$10 \log_{10} (14) + 30 \text{ dB}$

Satellite Xmit Ant. Gain +6 dB

Free Space Path Loss (146 MHz, 38,000 km) -168 dB

Multi channel Loading Factor

(downlink power sharing) -10 dB

Propagation Loss -1 dB

Antenna Pointing and Polarization Loss -2 dB

Ground Station Antenna Gain (KLM16C) +11 dB

Ground Station Feedline Loss (75 feet RG8/U) -1.5 dB

Signal Level Arriving at the Rx -124.1 dBm

It was earlier determined that a -137.9 dBm signal can be heard with the receiver set-up. The predicted signal-to-noise ratio of the OSCAR-10 downlink therefore is:

$-124.1 \text{ dBm} - (-137.9) = +13.8 \text{ dB}$

Sat Sig Level Rx Thresh Sig = S/N Ratio

Thus a ground station with an 11-dB gain antenna with 15 dB gain/2 dB noise-figure preamp into a 2-meter receiver with a noise figure of 5 dB, should hear OSCAR-10's 2m Downlink signals consistently 13.8 dB above the noise.

Simplified OSCAR-10 Uplink Budget

The analysis for uplink receiver threshold is somewhat easier for two reasons. First there are fewer obvious intervening variables for which to account (like multi-channel loading). Second, experience has been gained in manipulating the system variables of noise figure, noise temperature and receiver threshold sensitivity in the downlink example. The data to examine the uplink budget based on a typical station and the details known about OSCAR-10's receiver and antenna are:

Ground Station Power Out = 90 W +49.5 dBm

$\text{dBm} = 10 \log_{10} (90) + 30 \text{ dB}$

Ground Station Xmit Ant Gain (KLM 18C) +12 dBc

Ground Station Feedline Loss -1.1 dB

(50' of 7/8" hard line +

30' RG8/U foam)

Free Space Path Loss -178 dB

(436 MHz, 38,000 km)

Propagation Loss -1 dB

Antenna Pointing & Polarization Loss -2 dB

Satellite Receiver Antenna Gain +6 dB

Predicted Signal Level to Satellite RX -114.6 dBm

OSCAR-10's receiver has been tested and two parameters have been published to this point. The receiver noise figure measures 3 dB, and from this it is easy to calculate the receiver threshold sensitivity. Also, agc cut in has been measured at -108 dBm (less antenna gain values). It is not clear at this time what the relationship between receiver threshold sensitivity and agc cut in threshold really means.

Receiver Threshold Determination:

Receiver Noise Figure - 3 dB

Convert NF to a ratio Antilog ($0.1 \times 3 \text{ dB}$)

Ratio = 1.995

Convert Ratio to noise temp

Noise Temp = $(1.995 - 1) \times 290^\circ\text{K} = 288.6^\circ\text{K}$

Proceeding the same way we did for the downlink analysis, i.e., by specifying the background sky noise temperature and working back to the receiver input terminals.

1. Sky Noise Temperature (Ed. Note: plus the small contribution of the Earth.) - typical background noise temperature at 70 cm is generally agreed to be 100°K .

2. Satellite Antenna Feeder Loss - this variable is assumed to be on the same order as coupling loss, i.e., 0.2 dB. This corresponds to a loss ratio of 1.047, therefore, the equivalent sky temperature is: $100^\circ\text{K}/1.047 = 95.5^\circ\text{K}$.

3. Equivalent Feedline Loss Temperature is equal to the loss ratio - one times 290°K divided by the loss ratio. Therefore:

Equiv. Line = $\frac{(1.047 - 1) \times 290^\circ\text{K}}{1.047} = 13^\circ\text{K}$

Loss Temp. (1.047)

4. 3 dB Noise Figure Satellite Receiver

Expressed as a ratio

$3 \text{ dB} = \text{Antilog} (0.1 \times 3 \text{ dB}) = 1.995$

Noise Temperature =

$(1.995 - 1) \times 290^\circ\text{K} = 288.5^\circ\text{K}$

The system noise temperature, T_s , for the satellite receiver is therefore:

$T_x = \text{Equivalent Sky Temp} + \text{Equivalent Line Loss Temp} + \text{Receiver Noise Temp}$

$T_s = 95.5^\circ\text{K} + 13^\circ\text{K} + 288.5^\circ\text{K}$

$T_s = 397^\circ\text{K}$

From this value for T_s of 397°K it is possible to determine the satellite receiver threshold sensitivity using the equation:

$P_{n_w} = 10 \log_{10} K T_s B$

$= 10 \log_{10} (1.38 \times 10^{-23}) (397^\circ\text{K}) (3000)$

$= -167.8 \text{ dBW or } 137.8 \text{ dBm}$

It is also possible to convert system noise temperature, T_s , to system noise figure:

$SNF = 10 \log_{10} (T_s/290 + 1) \text{ dB}$

$= 10 \log_{10} (397/290 + 1) \text{ dB} = 3.74 \text{ dB}$

Having calculated how much signal the example station will present to the satellite's receiver and determined the receiver threshold sensitivity of the satellite, subtracting these two figures gives the predicted signal-to-noise ratio of the signal as it arrives at the satellite:

Signal Level to the satellite = 114.6 dBm
Satellite Receiver Threshold = -138 dBm
Predicted Signal-To-Noise = +23 dB

It appears that the rough predictions for a required ground-station power of 500 to 1000 W ERP are well within agreement with the analysis just performed.

Ground Station

90 W rf out less 1.1-dB line loss = 70 W

12-dB Antenna Gain (15.85×70) = 1109 W ERP

Thus, the analysis confirms, if somewhat laboriously, the general contention that 100 W out to a 10-dB gain antenna will suffice for OSCAR-10.

It is left to the student to plug in his own values to the downlink and uplink methods outlined here in order to determine not only how well he might expect to hear AO-10, but also to evaluate what effect on receiver

threshold sensitivity any proposed change in the station will have. Using the method outlined herein, one may easily discover the inherent cost/benefit ratio of using a better preamp, reducing line losses, moving the preamp to the antenna or increasing transmit power or antenna gain. In this way, any proposed change may be evaluated prior to purchase and implementation. Would that we were always so lucky as to be able to perform an effectiveness evaluation prior to making untoward purchases.

References

1. *RSGB VHF-UHF Manual*, Third Edition
2. *ARRL 1982 Radio Amateur's Handbook*, Chapters 8-1, 9-2

Comets

Please publish the attached *Call for Papers* for our 29th Annual VHF Conference to be held Saturday October 29th, 1983 at Western Michigan University, Kalamazoo, Michigan. Paper synopsis' are due for selection by August 15th and final papers are due October 1st.

We will provide proceedings for the conference participants and anyone who orders them by mail.

Reports from the past two years have encouraged us to continue a quality technical VHF Conference for those Radio Amateurs and others interested in the design, construction and testing of VHF equipment. — *C.A. Hesselberth, Chairman and Professor, College of Engineering and Applied Sciences, Department of Electrical Engineering.*

CALL FOR PAPERS

29th ANNUAL VHF CONFERENCE

CONFERENCE TO BE HELD ON SATURDAY, OCTOBER 29, 1983
8:00 A.M. - 5:00 P.M. WITH A 5:30 DINNER

AT WESTERN MICHIGAN UNIVERSITY, KALAMAZOO, MI
KOHRMAN HALL

Papers are invited for the 1983 Annual VHF Conference sponsored by the Electrical Engineering department. Principle emphasis will be placed on engineering developments applied to radio communication, design and construction on the frequencies of 30 to 1200 MHz.

FUTURE TRENDS & NEW IDEAS

Papers are solicited on from a wide range of areas including, but not necessarily limited to, those listed below:

Antennas & Transmission Lines
Applications of Microprocessors
Audio Frequency Equipment Used With VHF Transmitters and Receivers
Emergency Gear
Grounding and Shielding
Keying, Break-in & Control Circuits
Measurements & Test Equipment for VHF
Mobile and Portable Equipment
Modulation and Mixing
Narrow Band voice Modulation
Noise Reduction
Phase Locked Loop Uses
Picture Transmission & Reception
Power Supplies including Switchers
Production Technology and Model Building
Propagation
Recent Equipment/New Apparatus
RTTY
Satellite and Moon Bounce Topics
State of the Art Semi-conductors, I.C.'s and Filters With Applications
Transceivers

One of the basic purposes of this Conference is to provide a maximum opportunity to present findings by those experimenting, designing, constructing, testing, and inquiring into problems and methods applicable to VHF radio. Practicing engineers who are radio amateurs find this conference "planned for them".

This is an opportunity for beginning or mature researchers to report their findings to their peers. We especially encourage the unexperienced inquirers to obtain some experience by presenting a paper at our VHF Conference.

Authors wishing to present papers should send a synopsis or abstract (typically one or two pages with diagrams) describing the paper to Dr. Cassius Hesselberth, W8FLH, Chairman, Department of Electrical Engineering, Western Michigan University, Kalamazoo, MI 49008. Foreign authors are requested to have a U.S. contact.

Deadline for submission of synopsis is August 15, 1983. Speakers will be notified of acceptance by August 20th, 1983. Reproducible copy for the printed proceedings should be mailed to the Chairman one month prior to the day of the Conference.

Big is Better in Antennas!

*A photo essay by
WA2LQQ, KB2M & N4QQ*

Scientists and AMSAT Hams, using super antennas, bring EME to hundreds!

Radio Amateurs at the National Radio Astronomy Observatory (NRAO) at Green Bank, West Virginia, helped celebrate the Fiftieth Anniversary of Radio Astronomy's birth the weekends of 6-8 and 13-15 May. As previously announced, operations took place on 15 meters the first weekend and 70 cm EME operations took place the second weekend.

On the 15 meter operation, W3IWI reports over 250 QSOs completed using a replica of Jansky's original rotatable 20.5 MHz "Bruce Array." Among the rare DX worked were PZ, 5W, VU and ZD7. AMSAT stations worked included W6CG, AD6P, W6GC, WØRUE, WØCY, KO5I and WA2LQQ. (See photo.)



Jansky's "Bruce Array"



The NRAO 140' dish. Note polar mount. Also, the tiny rod poking out in space at the prime focus is the 2 m whip.

On the following weekend more than a dozen amateurs put the 140' NRAO radio telescope (see photo) on the amateur bands with a 70 cm EME weekend spectacular. More than 250 QSOs were made with about 40% of those ssb. Some ssb QSOs were "phone-patch quality."

The station at Green Bank operated for most of the event under the call K8HUH although W3IWI, WA4MVI and others operated under their own call signs for a least one QSO. Tests performed during the operation proved the incredible sensitivity of the station. EME returns were heard when cw signals were as low as 100 mW and less than 1 watt on ssb.

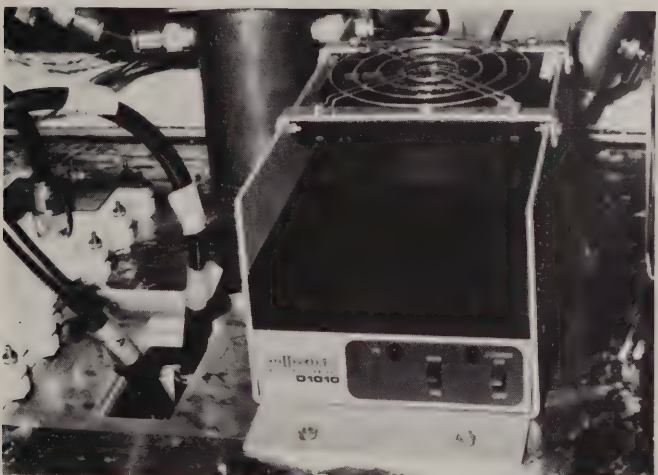
Overall the operation was hailed a huge success and one of the best operations of its kind in years.

The entire event was videotaped and photographed. A review of the operation will be made to the Central States VHF Society meeting later this year. Additional photos of both operations will appear shortly in *Orbit* and in these columns as space allows.

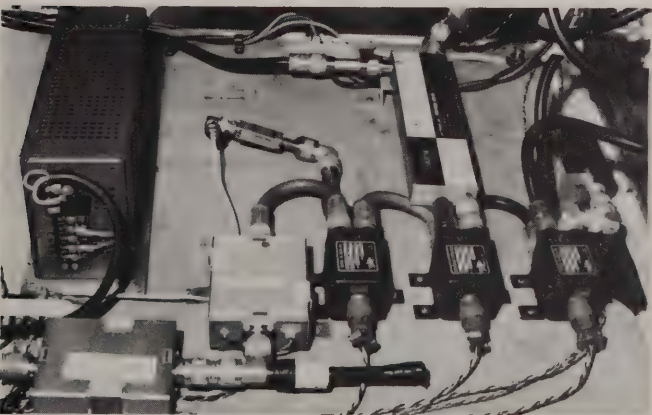
NRAO participants were: Mike Ballister, WB4ZJO/VK4ASC/G3IQB; Dave Brown, N4HTL; Bill Brundage, K8HUH; Tom Clark, W3IWI; Ken Cottrell, KA8QW; Mark Dannashek, WA1UAB; Hain Hvatum, N4FWA; Ken Kellerman, K2AOE/DJØRJ; Jerry McCulloch, VK2BMZ; Bill Meredith, W4OZJ; Mike Schwantke, KA8NQR; Dave Schaffer, W8MIF. AMSAT folk on hand (in addition to the above), WA2LQQ, K8OCL, W6SP, KB2M, N4QQ, WA4MVI.



Operators and observers. (l-r) N4QQ, K8HUH, WA4MVI, W3IWI.



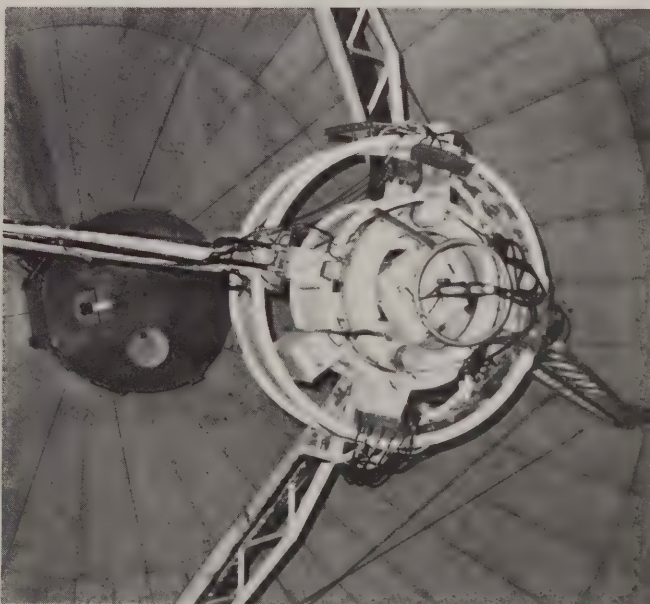
The D1010 in the prime focus equipment cabinet. Slight modifications were made to mount. Fan added for circulation.



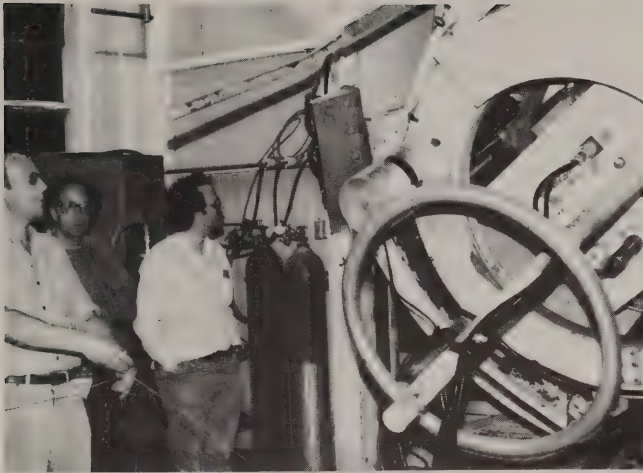
Inside prime focus equipment box. Transfer relays at right (3) and Lunar preamps (left and center). Two specially tuned Lunar preamps were used (GaAS FET). The first had a noise temperature of 35°K.



Tom Clark, W3IWI, AMSAT President (right) accepts donation of Mirage D1010 100 watt 70 cm amplifier from Everett Gracey, WA6CBA, center, Vice President of Mirage. Gene Niemlec, K2KJI, of KJI Electronics looks on at the presentation ceremony at the 1983 Dayton Hamvention. Mirage also donated a D24 power amplifier. Both were donated for use at the Greenbank EME DXpedition and provided excellent service with the D24 producing a powerful 55 watts. The D1010 peppered the moon with a 150 watts (!) output.



Looking at the prime focus from the service gantry. All the 70 cm equipment is in the box behind the silver-colored ring.



Jerry, VK2BMZ/W8 prepares a 5/8 ground plane for 2 meter "fun" after the moon set. The 2 m antenna was attached to the prime focus equipment bay seen here. Later it was elevated to 250' above the ground by pointing the dish skyward. Ken, K2AOE, NRAO scientist (center) and Orbit's KB2M are also seen here in the service gantry.



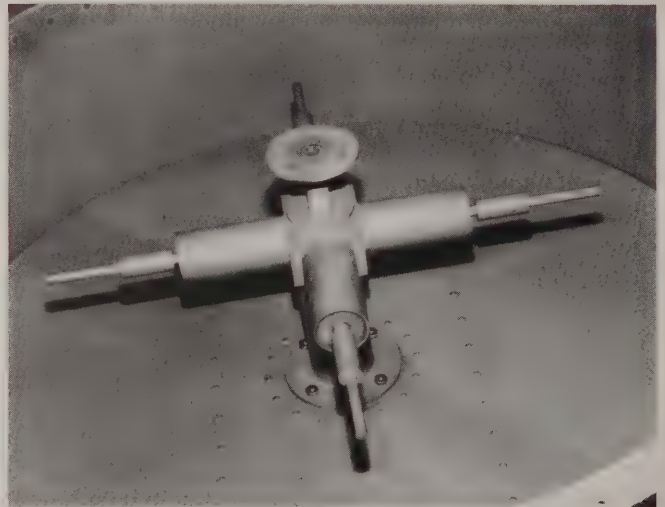
W3IWI (left) and W6SP yock it up on the service gantry while the "fun" 5/8 wavelength two-meter whip droops pathetically. The joke seemed to be working two-meter fm repeaters from the "5/8" mounted atop a 140' radio telescope! [Gufaw!]



Relegated to camera operator, WA2LQQ.



The 140' polar mount radio telescope at NRAO, Greenbank. The service gantry is at left. The enclosed work area, about 1000 sq. ft., is about 70 feet up. The entire gantry is on rails and moves towards the dish to allow access to the prime focus bay.



The business end of the equipment bay. This is the 70 cm circularly polarized antenna at the dish prime focus.



An abstraction of the dish supporting elements.



One of the largest steerable dishes in the world, this is NRAO's 300' monster. This instrument uses a transit mount.



KB2M gets in the act.



After moonset, everyone clambers up the gantry for a look at the equipment. Here W6SP (left), N4QQ help remove covers. K8OCL works the job from topside.



One of the earliest dishes, this is the original Grote Reber (Wheaton, Ill.) dish. It now stands at the entrance to NRAO. Reber was himself a ham and contributed to early radio astronomy work circa 1940.



G3IOR

Worldwide Satellite Activity

By Pat Gowen,* G3IOR

There has been little incoming information to report for this issue so the content may contain less than the usual input, being entirely dependent upon the inflow of needed data from active users of the satellites. As we plummet into the decline of what has been a quite magnificent sunspot cycle peak period, satellites become more in evidence as a means of propagation-independent amateur-radio communication, maintaining International contacts despite the Solar vagaries, but, with the great disadvantage that the hf means of reporting the results is now failing fast. The AMSAT nets, such a valuable means of communicating topical satellite information have been audible in Europe for less than 10% of the time for the past three months, and little improvement can be expected until November 1983, then only lasting until January 1984. AO-10 arrives at a much needed time, and will fulfill a major role in DX communicating, as well as a body for International nets. One or more of the earliest 'Radio' satellites has been making a regular appearance not only with a beacon on 29.400 MHz, but also with a transponder on too from time to time. Possibly the first person to identify this, as no beacon was evidenced at the time, was Nick, W0CA, who QSO'd JH7CKF way back in October when all current satellites were out of range, below the 'RS-6' passband in both uplink and downlink. Numerous QSO's were later accomplished on the old RS1/RS2 passbands, and later the beacon on 29.400 MHz was

identified as sending '55' with all the letters of the telemetry coming out as the figure five. Tracking indicates that it is 'RS-1' that is being heard, but a telephone call to the Moscow DOSAAF group by LZ1AB resulted in the UA boys reporting that it would be quite impossible that RS-1 was active, as both the battery and the solar cells were long dead, while RS-2 had a positive power-budget with its much larger solar-cell panels, and was active from time to time. Later reports confirmed that a transponder was occasionally active, sans beacon, and that quite separately a beacon signing '55' was being heard without an active transponder indicating that both 'RS-1' and 'RS-2' have not laid down.

The 'Radio' second string of 'RS-3' to 'RS-8' continue their fully active lives, and were extensively used for carrying messages from the 4K1 Antarctic expedition back home, as well as many experiments on what must have been a wonderfully quiet passband. At times the high-end beacons (29.451 & 29.501 MHz) on RS-6 and RS-8 respectively were commanded to the lower edge of the passband to permit fm experiments at the high end and codestore replay at the upper edge.

In early March, G3AAJ spotted a signal on 29.503 MHz sending typical RS TLM signing 'RS00' with signals peaking toward his South East, appearing some ten minutes later after a gentle lf drift toward the North-North-East, and naturally suspected a new launch, as this was coincident with an object coming from

Salyut-7. It reappeared some 87 minutes later to the SE, giving every appearance of a new orbiting 'Radio' satellite. Queries to the source assured us that no new satellite was in orbit, but tests in the Laboratory of a future model (sending 'RS00' until serialized) were underway. Unusual propagation had given Ron and other listeners in Southern England a path, while at the same time no signal was audible 120 miles to the North-East in Norwich, with the signal first scattering from the belts approaching the Equator, then later from the auroral belt ion concentration, making the forthcoming sputnik give every appearance of being in its eventual destination. Note that we have two digits in 'RS00' while previous ground-tests all signed 'RS0' with one digit only. We may thus conclude that a further cluster launch looks likely at some time in the future.

Other reports on 'new' satellites were usually explainable by either the observer hearing some of the figure and letter code groups of the codestore loaded in the Antarctic being sent down on either the upper or lower beacon or even the 'ROBOT' frequency (all are interswitchable) or were hearing the 145.850/29.350 MHz single channel cw transponder, present on all satellites, for the first time.

AO-8 failed, unfortunately, in early June and has not been operable since. This is a real loss!

In an interesting letter, Walt, W4DWN, reports that Bill, CN8COL, managed to work nine U.S. states (including Texas) and fifteen countries before leaving Morocco to give go 5U for a period of duty, from where we hope he became active. Walt reports that YV5APF has been active on RS-6, and that we might hope for activity from HP1 and VP5 soon, as he signed two such calls up into AMSAT membership at the Tropical Hamboree.

David, N4VW, has been making the most of some of the excellent sub-horizon possibilities that seem to occur during the ion build up prior to Aurorae. He has worked KH6IBA and KH6P, which with KL7JAI gave him his fifty states. Best of all was a good QSO with JH7CKF long beyond the theoretical maximum range. David is hearing good signals from UK9SAD and UK0SJD and has sent in a fascinating capture circle polar map indicating who was heard and worked at what point. G3IOR and RA0LFI (Vladivostok, way sub-horizon) made a good DX QSO under similar conditions.

If UoSAT-OSCAR 9 comes out of its newest problem causing the limitation of boom deployment, we shall have an incredi-



VE2VQ, KO5I, K1HTV, G3IOR, and JA1ANG, "snapped" by Martha at the last Board Meeting.



The well-equipped home station of Hans, HB9XJ, a regular on the satellites and AMSAT Nets. You may remember seeing the HB9XJ/M setup last year.

ble tool for investigating this auroral density re-angulation, as well as the phenomena of antipodal reception and of the dust-dawn attenuator also. To this end, John, GM4IHJ, has developed a most effective user-friendly computer program, called 'PROP9'. Using the W3IWI elliptical basic orbit mathematics as a good starter, he has produced an excellent graphics system with high resolution full color that will run on a ZX Spectrum 48K RAM computer. It displays a Mercator map of the World, shows the sub-satellite point, the antipodal point, the az-el of the satellite, all in response to an insertion of the date and time. The second menu displays a complete tracking program in azimuth and elevation every two minutes from the selected time, giving the sub-satellite longitude and latitude, the distance in Kilometres on a serialized basis. Menu 3 gives a series of sector maps of the sub-continental areas, e.g., S. America, N. America, Europe, Africa, Australia, etc. each with local time zone marked (in social operating hours or otherwise) and indicates the positioning of all the main cities relative to the footprint of the satellite, which may be moved along with choice of time. Also shown is the Doppler-shifted frequency of each beacon for each selected point of two minute shifts. The fourth selection puts up a great circle map of the world centered at the user QTH, shows the satellite position, the position where the sun is overhead, marks the station to satellite path, and marks the dust to dawn path around the World, at both the ground level and also at that of the satellite height. The earth poles, both rotational and magnetic are marked, and the listing table is added for reference and call-up as desired. John has produced a similar program, called 'MCP3', but without the great-circle addition, for the Phase III satellite.

While John is not interested in commercial reproduction, and prefers to use his all-too-short time in developing further programs, he has given a copy to your scribe, and will permit this to be copied to any non-commercial

genuine researcher on the proviso that the copyright is maintained and that the user informs John of his criticisms, uses, suggestions and further ideas for the program, so that GM4IHJ can provide further needed programs of value. Please note that the program needs graphics of greater than 250 by 150, (e.g. not TRS-80 or VIC) RAM memory of 33K exclusive of graphic display requirements (e.g. about 45K minimum total) and is currently for the Sinclair SPECTRUM 48K computer. These are on sale in England for \$260 and should shortly be available in the USA.

The 'Radio' RS series continue to function well, although 'RS-6' has been popping itself

off, both beacon and transponder, though sometimes one or the other, from time to time. The command station RS3A has no explanation, and can only assume it to be signals on the command frequency that are causing it to switch. Although 'RS-7' ROBOT works well, the ROBOT of 'RS-5' is all but useless over Europe for much of the time. By careful sub-horizon listening to the downlink when the continuous blocking is present, it can be determined that the major cause of the interference is a 145.825 MHz. FM repeater located in Sweden, which should long ago have been switched off or re-channelled to comply with the agreement made at IARU Region I five years ago to maintain a clear space-band from 145.800 to 146.000 MHz. One can only imagine the furor that will develop when 20-kHz. wide local FM is discovered on the Phase III pass-band, blocking the beacon, etc.

Despite the long standing resolution, many societies in Europe have done nothing to stop or shift the offending repeaters on 145.800 and 145.825 MHz nor to abate the indiscriminate use of FM, RTTY repeaters, simplex transmissions that cover the whole of the space band, some at quite high power. It appears that satellite users may have to take matters into their own hands to effect a cure when binding agreements are violated indiscriminately.

Finally, congratulations to K8HUH and W3IWI and the crew who gave so many good QSO's via OSCAR 0 in early May. I can now understand why AMSAT sources no longer give orbit numbers to satellites, as few know when the Moon was put into orbit. If only someone had thought of putting some aluminum cooking foil over some carefully selected shallow craters, it would be so much easier! With AMSAT-OSCAR 10 now up, it is anticipated that our already low input from readers to this column will become even lower with all the excitement of the new super-satellite. Any future column will depend upon you, the readers input.



Top and bottom of the KO5I tower showing the crossed Yagis for 435 and 145 MHz.

Around the World



By Kaz J. Deskur,* K2ZRO

Witnessing and appreciating the accomplishments of AMSAT, two French amateurs, F8ZS and F8FV asked themselves a question: "Why not us?" The consequences of this apparently insignificant event were profound; it led to the creation of a highly dynamic and competent organization that drew talent and expertise from all over the country. Its purpose: development, construction and launching of amateur satellites. (What else?)

First, the originators of the idea contacted the French National Center of Space Studies (CNES), various educational institutions, and some competent amateurs, to find out if they would be willing to participate in development of an amateur satellite. Fortunately, they were not disappointed. With this encouragement, a sponsoring organization called R.A.C.E. (Amateur Radio Club de l'Espace) was formed in 1979 to unite radio amateurs and other individuals interested in this activity.

The next step was to establish a technical branch of R.A.C.E., called ARSENE (Ariane Radio - Amateur Satellite Enseignement Espace), which included representatives of R.A.C.E., CNES, and several educational institutions. The task of this group, also known as Groupe Projet ARSENE, was to conduct feasibility studies and to present proposals and recommendations necessary for development and launching of a state-of-the-art amateur satellite. Projet ARSENE has

been divided into three main development groups: the first is responsible for the development of all on-board electronic hardware, (ARSENE); the second is working on the ground control concepts, (STELA); and the third, designs the propulsion system, (MARS).

The three primary groups have been further subdivided into speciality sections, such as electronics, mechanical, structural, packaging, integration, reliability, and tests. A steering committee, representing R.A.C.E., CNES, and educational institutions, supervised the project and was responsible for coordinating the activities of all subgroups.

After three years of intensive studies, the Groupe Projet ARSENE submitted a proposal for a satellite with the following basic specifications and orbital parameters:

Launch - the end of 1985 on Ariane Model IV, carrying two commercial satellites and....AMSAT's Phase IIIC

Apogee - 36,000 km.

Perigee - 20,000 km.

Period - 17 hr. 30 m.

Inclination - essentially equatorial orbit

Life - approximately 5 years.

Propulsion - solid-fuel apogee kick motor.

Stabilization - North-South, by means of nitrogen gas jets.

Uplink - 435.055 to 435.145 MHz (4 channels, 15 kHz wide)

Downlink - 145.855 to 145.945 MHz (4 chan-

nels, 15 kHz wide)

Downlink power - 2.5 W per channel; total 10 W.

Beacons - 145.8375 MHz and 145.830 MHz
Antennas - Circularly polarized (final version not determined)

Power - 12 solar-cell arrays; six on the body of the spacecraft (like AO-7), and six on three deployable panels; rechargeable batteries.

Package - Hexagonal (like AO-7) 80 cm diameter, with three deployable, wing-like, solar-cell panels.

Option 1 - 435-MHz/2.455-MHz transponder, 100- or 800-kHz bandwidth.

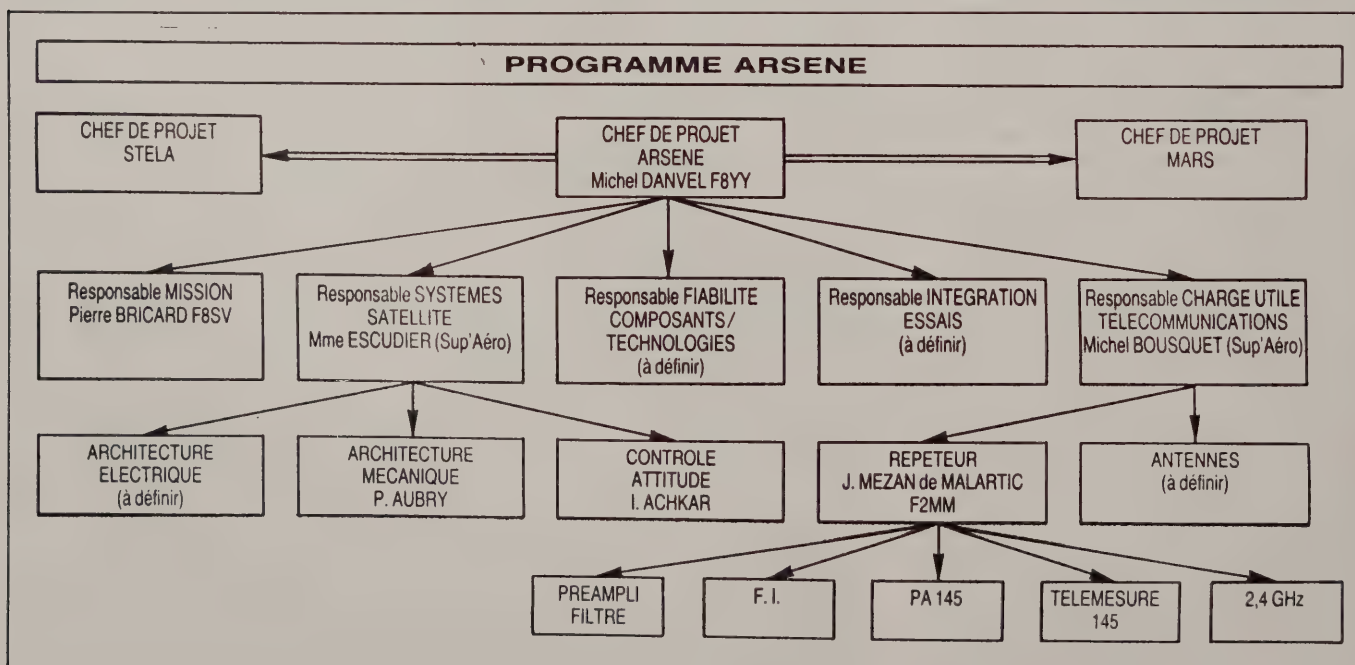
Option 2 - 10-GHz beacon.

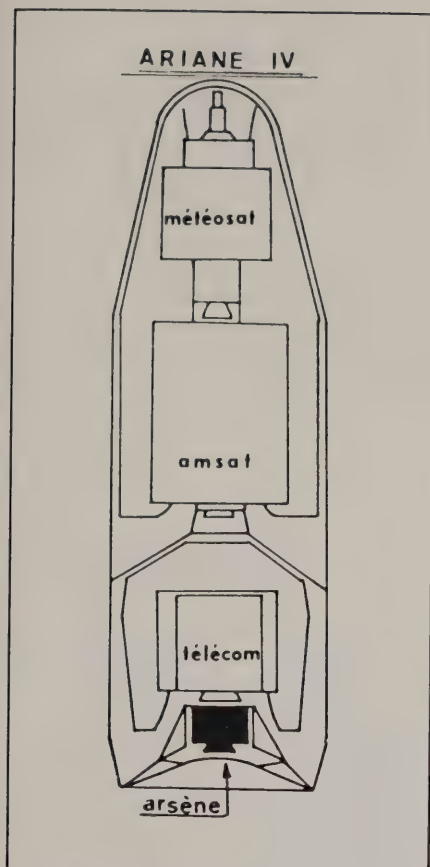
On board experiment - Radiation meter (dosimeter); GaAs cells; and "LISA", an unspecified experiment proposed by a youth club.

RX sensitivity - -122 dBm (0.18 uV) onset of AGC

RX overload level - -92 dBm (5.7 uV)

The transponder has its 100-kHz bandwidth split into four channels. All channels have a common rf input stage but the i-f stages, with independent AGC, are separated. The outputs of the i-f sections are recombined at the input of the second i-f stage. Employing this concept, the desensitization caused by an excessively strong signal(s) will not reduce the gain of the entire bandpass. Only the channel where the strong signal is received will be desensitized while the remaining channels will not be affected.





The high altitude of the perigee (20,000 km) will place the orbit of the satellite outside the Van Allen belt and prevent radiation damage to the components. The minimum necessary effective radiated power (ERP) of the ground station is estimated to be 125 W; 500 W ERP will actuate the AGC, and a 12.5-kW ERP signal will cause desensitization.

The leaders of Projet ARSENE are: F8ZS, Jean Gruau, President of R.A.C.E.; F8YY, Michel Danvel, Vice-President; F6GXY, Didier Delrieu, Secretary; and F3NL, Georges Aubert, Treasurer.

The organization of technical branch headed by F8YY.

The target-dates have already been established and the first is the freezing of the design concept, now scheduled for the end of 1983. Construction, tests, packaging, and engineering changes will last till the end of 1984. The entire package, ready for launching, should be completed by June 1985. (Source: Ondes Courtes Informations, Jan 1983, and REF's Radio Feb. 1983.)

Examining the orbital parameters of ARSENE, one can draw interesting conclusions. All subsatellite points of ARSENE will lie on the equator. The apparent motion of the satellite, in reference to the earth's surface, will average 5.6° (of longitude) per hour. Consequently, it will take the subsatellite point 64.6 hours, to cross the same meridian again. One may compare the celestial motion of ARSENE to that of a low-

altitude sun of a planet which makes one revolution in 64.6 hours. This implies that the risings (AOS) and settings (LOS) of ARSENE, as viewed from a particular location on the earth, will occur in about the same directions on the horizon, akin to our sunrises and sunsets.

Because the orbit of ARSENE is elliptical, rather than circular, the AOS and LOS direction will not be exactly the same, but will fluctuate within a range of several degrees; the maximum elevation at zenith will also vary a few degrees. This, again, can be compared to the seasonal differences of the apparent celestial motion of our sun. The satellite will serve equally the northern and southern hemispheres. However, locations nearer the equator will have a longer access time than those at higher latitudes. Stations situated at latitudes as far as $\pm 85^\circ$ will be able to communicate via ARSENE, although, their communication window will be of short duration. Stations located at middle latitudes will have continuous access to the satellite for about 30 hours; then, the satellite will set over the horizon, to rise again some 35 hours later. The slow apparent movement of the satellite will require readjustment of the antenna direction only every hour or so. Furthermore, the azimuth/elevation relation as a function of time within the period of the accessibility will practically repeat itself during each orbit.

We wish our French colleagues great success and we are looking forward to communicating via ARSENE.

W6SP SPACE PHILOSOPHER



By John Browning,* W6SP

From personal experience, most of us are convinced that "politics makes strange bedfellows." Nonetheless, we may have trouble agreeing on a meaning for the word "politics." The dictionary definition which comes closest to describing what goes on within AMSAT, is "interest groups competing for leadership".

AMSAT interests tend to fall into three broad categories; each with its own "political" leanings. On the left, we have the somewhat liberal engineers who advocate "technical change in the name of greater well-being." Over on the right are conservative operators who "oppose change in the established order." Each of the two has its own reasonable but differing perspective of the correct steering for our collective efforts. The inventors need new challenges while the users want to avoid equipment obsolescence. Their conflicting views provide a requirement for a third faction positioned precariously in the middle. In the view of the others, these "fence straddlers" lack both engineering and operation skills but know how to conduct meetings. They are therefore relegated to an unpopular but essential referee role and are called "management."

AMSAT managers make decisions after comprehensive consideration of available information. Their biggest challenge is to arrive at policy which represents a reasonable balance between left and right. Their judgment results in action which is usually acceptable to both engineers and operators but which is never optimum for either. Important decisions are subsequently reported in *Orbit* and *Amateur Satellite Report*. So far, the incumbents' judgment has been supported by a majority of the membership. Should a loss of confidence develop, the members can exercise their franchise and "throw the rascals out!"

The engineers and operators have some common convictions. They both are enthusiastic supporters of the amateur satellite program. They both cite AMSAT's objective "to encourage development of skills and the advancement of specialized knowledge in the art and practice of amateur radio communications and space science". And they both can be heard to exclaim, "You are spending my money for what?"

AMSAT differs from a commercial enterprise in our means of funding. Since we don't sell our product, we must constantly solicit donations. The gifts come from the engineers

and the operators. Both must be treated fairly. In commercial broadcasting, the user pays the entire bill and dictates the programming. In amateur space, much of the available funding comes from serious experimenters who are searching for communications knowledge. Their donations are directed for use on specific projects. Without the satellite builders, the users would have nothing to use.

The referees conscientiously try to call the shots as they see them. They are well aware of the hazards of running in the middle of the road. They welcome constructive criticism. But they get discouraged with comments reflecting on their dedication. Particularly demoralizing are general observations like "AMSAT should reorganize to be a big business operation." We are not big as far as management is concerned. We cannot afford to be. We are run by a few volunteers who donate their valuable time and expenses for a derived sense of useful accomplishment. Funds are allocated to the referees only when critical skills are not available free. Those on the fence have their own unique perspective. There is plenty of room. Climb on up and enjoy the view!

AMSAT News



Organizational items of interest to all members of the Radio Amateur Satellite Corporation

AMSAT Membership Drive Offers New Rig

AMSAT has announced a six-month membership drive that offers major incentives for sponsoring new members. There will be many prizes and awards but the top prize is a brand new, super OSCAR satellite rig, the Yaesu FT-726R. The new FT-726R is unique in that it allows Mode B and Mode A operation with a single transceiver. The FT-726R transceiver operates full duplex, i.e., can transmit on one band and simultaneously receive on another. For example, configured for Mode B, the rig transmits on 70 cm and receives on 2. Similarly, for Mode A, the new FT-726R transmits on 2 and receives on 10. With all the options cranked in, the prize is worth over \$1,400. An additional 10 prizes will be awarded to the next ten finishers. Prizes will include ham equipment, books and other premiums.

Everyone who brings in a new member will get a prize, moreover!

If you:

Sponsor

1 new member

2 new members

3 new members

4 new members

You Get

Your name in space (see Aug. *QST* or Callsign badge).

T-Shirt or Belt Buckle.

An A.S.E. credit or a copy of the new ARRL/K2UBC book, "Satellite Experimenters Handbook."

One year AMSAT Membership or 1 year ASR.

Rules for the contest as follows. Points are awarded for each new member signed. The schedule for award of points is one point for a regular (annual member), two points for member society and three points for a new life member. The contest period commences 1 July 83 and ends 31 Dec. 83. Only AMSAT members are eligible to participate. If you yourself become a member you get a point. If you upgrade to Life Member from regular member you still get three points. You cannot let your annual membership lapse and then renew to count as a point.

Only entries on official AMSAT membership applications count. Locally reproduced copies of official membership applications are OK. The entry must contain the name and address of the applicant and his sponsor (you) along with your membership number to be valid. All applications must be sent to

AMSAT, P.O. Box 27, Washington, DC 20044, postmarked not later than midnight, 31 Dec. 83.

Membership applications may be obtained in any reasonable quantity from AMSAT at the above address. Send a SASE of sufficient size and with adequate postage to accommodate the quantity you request. A book of 100 applications will cost about \$1.20 to mail first class and requires an 8" x 10" envelope. They can be shipped for considerably less by library rate.

Announcement of the winner and award of the prizes will be made not later than 1 Feb. 84. Standings of contestants for comparison purposes will be announced in the AMSAT media at appropriate intervals throughout the contest period. Decision of the judges is final. In the event of a tie, a random drawing will be made. An applicant becomes a member when an application accompanied by payment in full is received. No time-payment plan applications will count for points towards the prize.

The main prize for this contest, retail value with options as offered, is at least \$1,400. The prize has been donated in support of AMSAT by Yaesu-Musen of California through the kindness of Mr. Chip Margelli of Yaesu.

According to AMSAT President Elect WA2LQQ, the objective of the membership drive is to raise the membership level from its

present level of about 4,000 to at least 7,777 by years end. Everyone is encouraged to take up the challenge and try for the grand prize!



AMSAT UK Secretary, Ron Broadbent, G3AAJ (left) presents AMSAT President, Tom Clark, W3IWI, a check (cheque) for \$2,000. The cheque (check) represented a donation from AMSAT UK for general operations. Thanks chaps!



The Yaesu FT-726R as shown on display at this year's "Dayton"

AMSAT UK Honors SRI Team

AMSAT UK Secretary Ron Broadbent, (G3AAJ, (left) presents the illuminated scroll to Dr. Robert Leonard, KD6DG, of SRI International, Menlo Park, California. The ceremony took place in London, 1 Mar. 83, when Dr. Leonard attended a ceremony marking the UoSAT-OSCAR 9 rescue mission. Dr. Leonard's team at SRI (See cover *Orbit* #12) overcame a number of technical problems to successfully silence the 2 meter beacon. A desense problem had prevented commanding UO-9 with both 2m and 70 cm beacons simultaneously on. (See *ASR* #42, 22 Sept. 82). KD6DG, Director of the Radio Physics Laboratory at SRI, accepted on behalf of the SRI team including WA6DIA, KB6LZ, W6IRA, K6TDR, W6YBL, W6MX1, W6GXN, W6WMC, KE6D, Ron Presnell. (The scroll presented is reproduced below.)



G3AAJ (left) presents scroll to KD6DG.

ARRL Mid-West Convention

AMSAT was represented at the ARRL Midwest Division Convention this year by W0RPK, W0CY, K0CY and N0AN. A booth was staffed from early Saturday morning until the convention closed at noon on Sunday. A seminar was held on Saturday afternoon with 100+ attendance. W0RPK was present at the media announcement when the W5LFL/STS-9 mission was made public.

Booth operations were highlighted by the demonstration of AMS-81 and a videotaped Mode J QSO created by N0AN.

Seminar highlights included introduction of Hasan Schiers, N0AN, as the new AMSAT Area Coordinator for Iowa. Hasan (as he likes to be called in association with satellite activities - given name is Robert or Bob) is a very competent OSCAR operator and very active on Mode J. He is a worthy replacement for W0RPK who was recently named Assistant Vice-President of Operations.

Jim McKin, W0CY, covered OSCAR basics with a several-page handout to all attendees. W0RPK covered Phase IIIB including operational improvements (DX and access time) and station requirements.

Roy Neal, K6DUE, Science Editor for NBC news, was present to announce the W5LFL/STS-9 mission. Roy, Vic Clark, W4KFC, ARRL President, and W0RPK were together with the story at a media session on Saturday afternoon. Roy announced it at the ARRL forum and then covered it again during his banquet address.

Roy is obviously a great promoter of the amateur space program and mentioned AMSAT and Phase IIIB several times during his address.

Roy has been retained by the ARRL to produce an educational videotape which the league field organization will take into classrooms before the mission. Vic sees a massive classroom oriented realtime demo program during the flight. (The film crew was at the AMSAT Lab 12 July. Ed.)

To the Team at
**STANFORD INSTITUTE
INTERNATIONAL**
of The United States of America

The Committee & Members
Amateur Satellite Organisation
of The United Kingdom
in association with the U.O.S.A.T.
Project Team at
The UNIVERSITY of SURREY
England

Wish to record our Sincere Appreciation
for the
Maximum Effort and Success in
regaining control of U.O.S.A.T.
on Monday 20th. September 1982

We would like to thank

BOB FOSS WA6DIA • BOB LIVINGSTON KB6LZ • GARY PRICE W6IRA
DOUG LEE K6TDR • ROY LONG W6YBL • GIL ROACH W6MX1
BOB LEONARD KD6DG • HENRY OLSON W6GXN
HOWARD ZEIDLER W6WMC • KARL LIND KE6D • RON PRESNELL

and would ask that they be pleased to receive
this Illuminated Scroll dated this day 1st March 1983
as an Expression of Goodwill
& Co-operation between
Fellow Radio Amateurs.

Signed for & on behalf of

Dr. Arthur B. Leonard
G2UK
Honorary Chairman



Ronald J.C. Broadbent
G3AAJ
Honorary Secretary

Amateur Radio Month

On June 2, 1983 Iowa Governor Terry E. Branstad signed a proclamation declaring June, 1983 as Amateur Radio Month. During the ceremony Governor Branstad was presented with a framed picture of the AMSAT Phase IIIB spacecraft as an example of high-technology projects Amateur Radio operators in Iowa participate in.

Among other Iowa hams taking part in the ceremony are Bob McCaffrey, K0CY, (second from left) AMSAT AMS-81 distribution manager, holder of OSCAR WAS and ARRL Iowa Section Manager. Third from left, presenting the picture to Governor Branstad (second from right) is Ralph Wallio, W0RPK, AMSAT AVP-OPNS and happy resident of Iowa.

This presentation was an all-ham effort. The Phase IIIB picture was taken by Dick Daniels, W4PUJ and framed by Bob Eaton, K0HFU. The ceremony picture was taken by Ed Mulvin, WB0IFF.

The small brass plaque on the picture reads:

AMSAT Phase IIIB Satellite
Presented to Governor Terry E. Branstad
Amateur Radio Month - June, 1983



Amateur Radio Month in Iowa. See text for details.

Seek Net Control Stations

With the departure of one of its Net Control Stations (NCS), AMSAT is in need of at least two additional HF NCS. Bob Nickels, KE0T, is relocating and cannot continue his former role as NCS. Consequently Net Manager W8QW has issued an urgent appeal for NCS's to serve the Sunday AMSAT International Nets.

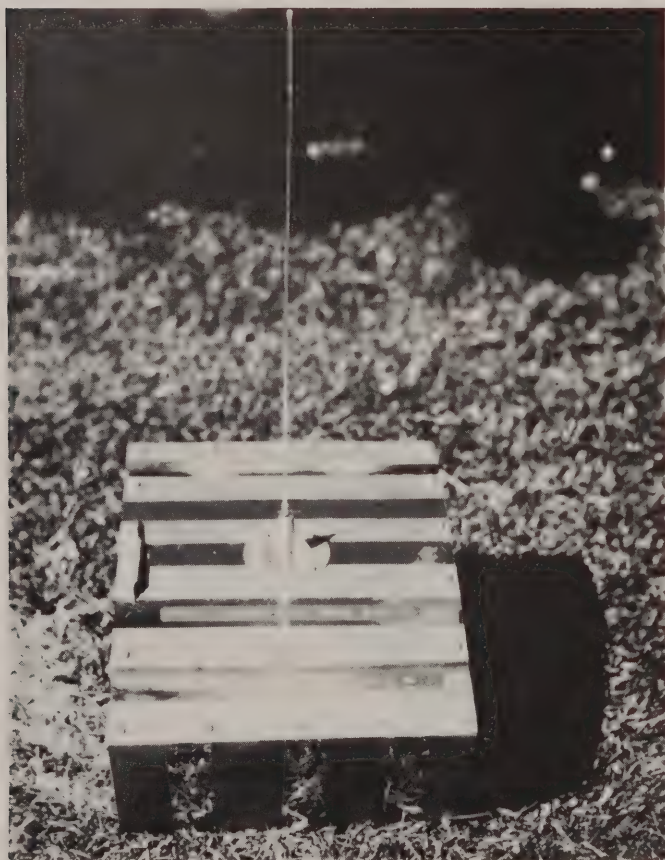
The AMSAT International Nets meet on

Sunday at 1800 UTC (21.280 MHz) and 1900 UTC (14.282 MHz) weekly. The remaining team, N3AR, KO5I and W8QW require at least two additional team members in order to maintain the desired once-per-month rotation with a back-up for personal contingencies, etc.

Basic requirements to become an AMSAT NCS are having a competitive signal on 20 and 15 (suggested 1200-2000 watts PEP, good tri-band beam at 40' or above), a reasonably

good speaking voice and the willingness to spend some time preparing bulletin material. News items, bulletins and other information are provided from AMSAT HQ. This is a challenging, responsible position for which an understanding of and deep commitment to the ideals of AMSAT's mission and purpose is essential.

AMSAT President Tom Clark, W3IWI, has called the AMSAT Nets "Our primary communication element in the field organiza-



Remember the way things were?

ANNUAL MEETING

This years annual meeting will be held November 12 at the Applied Physics Laboratory of John Hopkins University near Laurel, Maryland.

If you plan to attend, please fill out the form below and return no later than October 1 to: AMSAT, 850 Sligo Avenue, #601, Silver Spring, MD 20910.

Annual Meeting Registration

- ☐ Yes, I will attend the AMSAT Annual Meeting!
☐ Yes, I will attend the meeting dinner!

Name _____ Call _____

Address _____

Number of people attending in my party _____

Remarks _____

tion."

AMSAT President Elect, Rip, WA2LQQ, says: "AMSAT's HF Nets will always be essential in getting new people aboard the satellite program. It is here (on the HF bands) we find our new members and point them in the right direction. We absolutely require competent, highly motivated people out front with the HF Nets. Without them, we have in effect slammed the door on our future!"

Wray, W8GQW, points out AMSAT HF Nets will continue to play a major role in AMSAT's information dissemination system even beyond the advent of AMSAT OSCAR 10. AO-10 "Will not," he says, "eliminate the need for the HF Nets in the near future. We will be employing both resources in our quest for better communications."

Would you like to be a part of the AMSAT Net Team? If so, please contact Net Manager Wray Dudley, W8GQW, 1617 W. McKaig Rd., Troy, OH 45373 or call if you wish at 513-339-2254.

Japanese Satellite Project Begins

JAMSAT, the Japanese AMSAT affiliate will soon be designing and building an indigenous OSCAR according to JAMSAT/AMSAT Liaison Officer Harry Yoneda, JA1ANG. Harry also serves as AMSAT Director. The project will be a joint undertaking of JARL and NASDA. (JARL is the Japan Amateur Radio League; NASDA is the National Space Development Agency [of Japan]; similar to NASA, ESA). JAMSAT will provide key technical support in areas of design, development, test and integration. Dubbed JAS-1 for Japanese Amateur Satellite #1, the project was recently approved by Japanese authorities after several years of behind the scenes negotiations. The sensitive nature of the negotiations precluded earlier announcements according to JAMSAT officials. A 1986 launch is anticipated.

Mikiyasu (Miki) Nakayama, JR1SWB, will head the JAMSAT team as task leader for the project. It is not clear at this juncture what the final name of the satellite will become. This will be Japan's first satellite although JAMSAT has been a very active contributor to prior projects. Most prominent is AMSAT-OSCAR 8 where JAMSAT built the Mode J (for JAMSAT) transponder. Several of the key components of both Phase IIIA and B also were JAMSAT contributions.

JAS-1 will be placed in an 1500 km circular orbit inclined 50 degrees. It will be very similar to AO-7 in its orbit. According to JR1SWB the payload will include both a Mode J-type linear transponder and a PACSAT-like digital transponder. The launch vehicle will also be indigenous to Japan. The H-1 launcher has recently enjoyed good success in placing communications and weather satellites in service for the Japanese growing requirements.

JR1SWB is currently in the U.S. attending the West Coast Computer Faire in San Francisco. Later he will travel east visiting key AMSAT officials including KA9Q and W1HDX. Miki represented JAMSAT at the Paris conclave of amateur satellite builders last October and is a recognized leader in the community.

Shuttle Astronaut Owen Garriott to Communicate with Radio Amateurs on Earth

Victor C. Clark, W4KFC, President of the American Radio Relay League and Dr. Thomas A. Clark, W3IWI, President of the Radio Amateur Satellite Corporation (AMSAT) today announced acceptance by the National Aeronautics and Space Administration (NASA) of a proposal submitted by their two organizations to include an amateur radio station aboard an upcoming Shuttle mission. They said that in giving its go-ahead, NASA's Associate Administrator for Manned Space Flight, Gen. James Abrahamson, has designated the STS-9/Spacelab flight, to be flown this fall, as the mission on which the amateur radio equipment will be carried.

The Space Agency's approval is based on a number of conditions which both ARRL and AMSAT find entirely acceptable. Among them are that the use of the amateur radio equipment aboard the Shuttle shall not interfere with its planned mission. Operations will be carried out on a non-interference basis during the Shuttle crew's "free time." It is also understood that special amateur radio transmitter and receiver will be furnished by the amateur radio community at no cost to NASA.

The primary mission of STS-9 is to carry the joint U.S.-European Spacelab aloft in the Shuttle's cargo bay. This particular mission was selected for the amateur operation because it includes in its crew Dr. Owen Garriott (Amateur call letters W5LFL), who will serve as the operator of the spaceborne ham radio station. Dr. Garriott has been an active radio amateur for many years and is eagerly awaiting the chance to pursue his hobby from space. He commented that amateur radio has been important in developing his own professional skills and those of many others around the world involved in technical professions. He is especially pleased that NASA has given the nod for the operation as he feels that it will be instrumental in bringing the space program home to many people in this country and the rest of the world. He notes that the orbital track to be taken on the STS-9 mission makes it especially suitable for communicating with a large number of amateurs as it extends farther north and south than did earlier Space Shuttle missions.

ARRL President Vic Clark expressed his great pleasure at the NASA decision. He said that the League represents the radio amateurs of this country and, through its affiliation with the International Amateur Union (IARU), those of many countries throughout the rest of the world. Thus the ARRL is extremely happy to play a key role in this worthwhile endeavor. The joint ARRL/AMSAT proposal approved this week by NASA calls for the ARRL to furnish the special amateur radio equipment for use on the Shuttle. The ARRL will also organize and coach earth-bound amateurs in techniques and procedures for rapid and efficient communication with the orbiting astronaut. This will be done through the pages of the League's monthly magazine *QST*, which reaches some one hundred and fifty thousand licensed amateurs, and its affiliated clubs throughout the U.S., Canada and the rest of the world.

Dr. Tom Clark (no relation), President of AMSAT, was also enthusiastic about the impending amateur operation from space. He

noted that AMSAT is responsible for selecting appropriate frequencies and operating modes for the "ham in space" operation and made many of the initial contacts with NASA officials which preceded submission of the proposal. Dr. Clark noted that AMSAT is an international organization devoted to promoting amateur space involvement. Since its birth in 1969, AMSAT has been responsible for the successful orbiting of five "OSCAR" (Orbiting Satellite Carrying Amateur Radio) satellites, all of which were launched as secondary "piggyback" payloads on NASA missions. The newest OSCAR built by AMSAT is designed to provide world-wide communication among radio amateurs, is now poised for launch on a European ARIANE flight in June.

Another key organization involved in putting an amateur station aboard the Shuttle is the Johnson Space Center Amateur Radio Club. This group, known by the amateur radio call letters W5RRR, numbers among its members many experts well versed in testing and preparing equipment for manned space missions. Members of this club are charged with a number of tasks to insure that the ham equipment used on the Shuttle will function properly and will not disrupt other vital spacecraft functions. Included in these tasks are the adaptation of an existing Shuttle antenna design for use on the internationally recognized "Two Meter" amateur radio frequencies.

With the flight of STS-9 this fall, amateur radio will continue its long history of service. Amateur radio will provide the first time in the history of man-in-space when the general public will be able to communicate directly with an astronaut in orbit—It is expected that tens of thousands of individuals, including elementary and secondary students, citizens of developing countries and the "man on the street" will experience the excitement of hearing the words come from space "CQ from W5LFL aboard the Space Shuttle."

For additional information, contact:

Radio Amateur Satellite Corp. (AMSAT)
850 Sligo Avenue
Silver Spring, MD 20910
(301) 589-6062

"Official Journal of the USATVS"

sample issue only \$2.50 PPD

"Did you AMSAT members know that you already possess most of an Amateur TV Station? Imagine, working and 'seeing' your friends with just the addition of a downconverter and TV set! Send \$2.50 ppd. today for a sample issue of the USATVS Journal."

AMATEUR TELEVISION MAGAZINE™

"OUR 16TH YEAR — SINCE 1967"

	Surface U.S./Canada	Surface All Mexico	Airmail Foreign S. America	Airmail All Other Foreign
1/2 year	\$ 10.00	\$ 13.00	\$ 20.00	\$ 23.00
1 year	\$ 20.00	\$ 26.00	\$ 40.00	\$ 46.00
2 year	\$ 38.00	\$ 50.00	\$ 78.00	\$ 90.00
3 year	\$ 56.00	\$ 74.00	\$ 116.00	\$ 134.00

"FOR THE SPECIALIZED COMMUNICATION RADIO AMATEUR"

QCD Publications
c/o Mike Stone WBOQCD
P.O. Box H
Lowden, Iowa 52255-0408

AO-10

The First Two Weeks!

(From *Amateur Satellite Report*)

The hopes and dreams of radio amateurs world-wide were advanced recently when on the morning of 16 June, a new OSCAR, the most advanced amateur spacecraft ever conceived, was successfully launched into orbit.

The scene might have come from the pages from a Hollywood script. Barely three years after a tragic end to the Phase IIIA bird, Phase IIIB became AMSAT OSCAR 10 on 16 June. All who listened to the ALINS (AMSAT Launch Information Network/Service) realized at that instant that a page in amateur radio history had been turned. And pride in the completion of this critical phase — getting to orbit — swelled in tens of thousands. AMSAT President Tom Clark, W3IWI, speaking on ALINS from his remote Mohave Desert (California) temporary NASA work station, was especially proud at having reached the milestone. It was W3IWI who rallied the team together after Black Friday, 23 May 1980, when Ariane LO-2 and Phase IIIA became the world's most famous rocket-powered submarine! Now, however, the joy of thousands was crystalized in images of Ariane L6 parting the clouds easily, triumphantly, and gracefully placing ECS-1 and moments later Phase IIIB successfully into orbit.

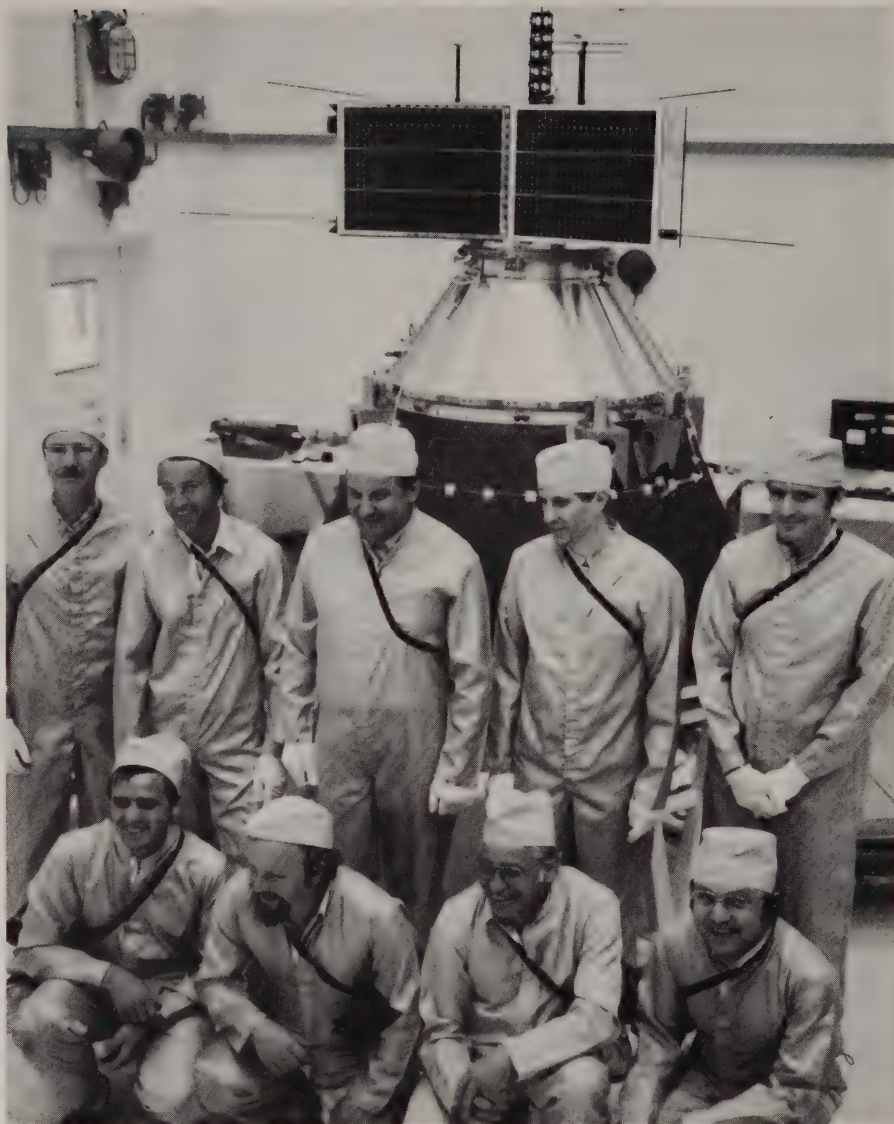
Here's a summary of the events leading up to launch and the first two weeks after launch.

The launch date of 16 June had been holding steady for about a month. A slip from 3 June had been preceded by a slip from May. When the Phase IIIB launch support teams from Germany, South Africa and the U.S. returned home leaving a skeleton caretaker crew at the launch site, it was hoped the 16 June date would hold. It did.

Dawn at the launch site at Kourou, French Guiana, was much the same as many steamy mornings. In the tropics (Kourou is within 5 degrees of the equator), seasons aren't easily discerned. The threat of bad weather, moreover, had not materialized. Launch time was set for 11:59 UTC, the opening of a 90 minute launch window.

The countdown at Kourou proceeded well with no glitches. Meanwhile, tens of thousands of listeners around the world consciously or otherwise leaned slightly closer to their radios, the better to hear the countdown procedure. The ALINS superbly organized by WØRPK and K1HTV went virtually perfectly. Some propagation deficiencies to the South Pacific and elsewhere were later noted but for the most part ALINS effectively blanketed the world. HF stations W1AW, WA3TAI, WØRPK, NØAN, AIØZ, WA6GFY, W6VIO, W3OZ, G3AAJ, G3RWL, KH6SP, KH6GMP, and others provided live coverage from 160 through 2 meters. Dozens of other secondary ad hoc relay points sprang up around the world too.

Center of the network was located at the AMSAT Ground Command Center (GCC) at NASA's Goddard Space Flight Center, Greenbelt, Maryland. From there both landline and rf links connected to hf and vhf relay stations. For example, the lab transmit-



The launch support crew: Upper: (l to r) W4PUJ, DK4VW, DJ5KQ, W3GEY, ZS1FE. Lower: W. Gladisch, W. Mueller, K. Mueller, DJ4ZC.

ted on 2 meters to the AMSAT repeater, W3ZM. WA3TAI in the Washington, D.C. area picked up the 2 meter input leg and retransmitted the quality audio on the 20 meter band. From the lab a landline link was established to an American Bell conference bridge in New Jersey. Relay stations from as far east as England (G3AAJ) dialed into the bridge for ALINS audio to retransmit to Great Britain and Europe. From as far west as Hawaii another (WH6AMX) dialed in to relay to KH6SP and KH6GMP who relayed on hf to the Pacific region. Other stations across the nation did likewise for assigned hf and vhf coverage zones. WA2LQQ provided the narration of the action interspersing background information on the spacecraft and launcher with the countdown status and progress. An open audio line from NASA (Goddard) to ESA (Kourou) was monitored at the lab and provided background audio to Rip's account. KB2M sat at the controls of the audio mixer panel providing superb control of the complex interfacing and mixing that was required between multiple ports. K1HTV applied his expertise to lashing the system together at the lab while system ar-

chitectural control had been established by WØRPK. Thus, the world of amateur radio could follow in real-time the unfolding events that mid-June morning.

Then all knew the final moments were here. Much as the approach of a diesel locomotive racing toward you, you knew that the moment of truth was at hand. Would you be hit by the train? The enormity of the moment grew as the mental second hand swept through its final arc...as another mental second hand swept through major milestones leading to this moment: Black Friday...L5 lost...Shake and bake tests complete...more. Now the story would be told. Ten, 9, 8...WA2LQQ's voice-over the ESA controller spoke the words all had waited to hear. Five, 4, 3, 2, 1. Hearts stopped. Or exploded in tension. The next words heard, "Ignition" signaled the beginning. Or was it the end? Then, "Liftoff. We have liftoff." We were on our way!

With enviable precision the Ariane L6 launcher ticked off according to the timeline. ASR readers followed the script second by second. The minutes sped by now. Launch time was announced as 11:59:03.360 UTC 16

June. Then it was time for ECS-1 to be deployed. At 12:14:55.051 it became a new earth satellite. But what about Phase IIIB? Again the tension grew. Moments later it was done! At 12:16:53 UTC, AMSAT OSCAR 10 was born! The Phase III era had begun!

We were in orbit! Next all wondered if AO-10 had survived the ride. Would the telemetry beacons turn on when scheduled two and a half hours later? ALINS was shut down after a few minutes of recap and reminders of follow-on, post-launch ALINS.

By 14:45 those at the lab knew the Mode B beacon should be on. Moments ticked by while all waited for the phone to ring; waited for reports from the Pacific region that AO-10 was alive and talking. Mercifully the phone rang at about 14:55 UTC. It was Ian, ZL1AOX. He said the he and a dozen or so of his colleagues in New Zealand had all heard AO-10 when it first came on at about 14:45 UTC. Later it was learned that JR1SWB, JAIANG and dozens of their colleagues had heard AO-10 as well at the exact moment of Mode B beacon activation. AMSAT OSCAR 10 was alive and talking!

Soon stations around the world were reporting reception of the beacon on 145.81 MHz. Joy prevailed.

Then some bad news. Initial telemetry frames analyzed by the Ground Command Stations (GCS) indicated a poor sun angle. Somehow the attitude of AO-10 was wrong. Without some remedial measures AO-10 could be in serious thermal and electrical troubles soon. DJ4ZC promptly commanded the beacons to a 1/3 duty cycle (20 minutes on, 40 minutes off per hour) to reduce power consumption. The solar panels were being illuminated at only a very shallow angle (estimated at about 15 to 20 degrees). That meant less energy to run the satellite. It also meant the spacecraft would be running colder than designed. In some locations it would be frozen down to -20 degrees C or colder. This was cause for serious concern since the propellants, if cooled to that temperature, could freeze solid with potentially catastrophic consequences. However, the move to reduce power consumption was effective. The net power budget remained positive so there was small risk of battery depletion given a stable situation. That gave some time for analysis and for a solution to be worked out.

Within a day or two it became evident that the major danger had been passed and that there were natural forces at work that would help remedy the incorrect sun angle with little or no outside intervention. Although some discussion of using the magnetorquers for reorientation had transpired, it was considered too risky to use the torquers at this point. With no sun-reference for the sun-sensors, no timing reference could be attained for pulsing the magnetorquers. Beyond that, the amount of power available combined with the ineffectiveness of the torquers at this attitude spoke against their employment for the moment.

Within a week it had been ascertained that the improvement in sun angle amounted to between 3 and 4 degrees per day. When the sun angle had been improved by about 30 degrees, the sun sensors would begin to pick up the impulses that were needed to synchronize the magnetorquer pulsing. The sun

sensors have a range of ± 45 degrees. So it appeared a waiting period of between 10 days and two weeks was the best option. The "helpful" forces that were operating on the spacecraft appeared to be three-fold:

- a) The natural movement of the earth and its satellites around the sun (seasonal movement amounting to about 1 degree per day)
- b) Atmospheric drag
- c) Induced magnetic fields in the spacecraft caused by Eddy currents themselves results from the passage of a conductor (AO-10) through the geomagnetic field.

These effects accounted for most, if not all, of the observed improvement in the sun angle as seen from AO-10.

Things were improving and hopes were buoyed by the happy prospects that lay ahead. Then a big surprise! By a week after launch, while analysing the sequence of illumination of the solar panels in an effort to determine attitude and spin in the absence of the solar sensors, it was discovered that the spacecraft was not only *not* spinning as fast as it should have been...it was spinning in the wrong direction! And at only 2.5 RPM!

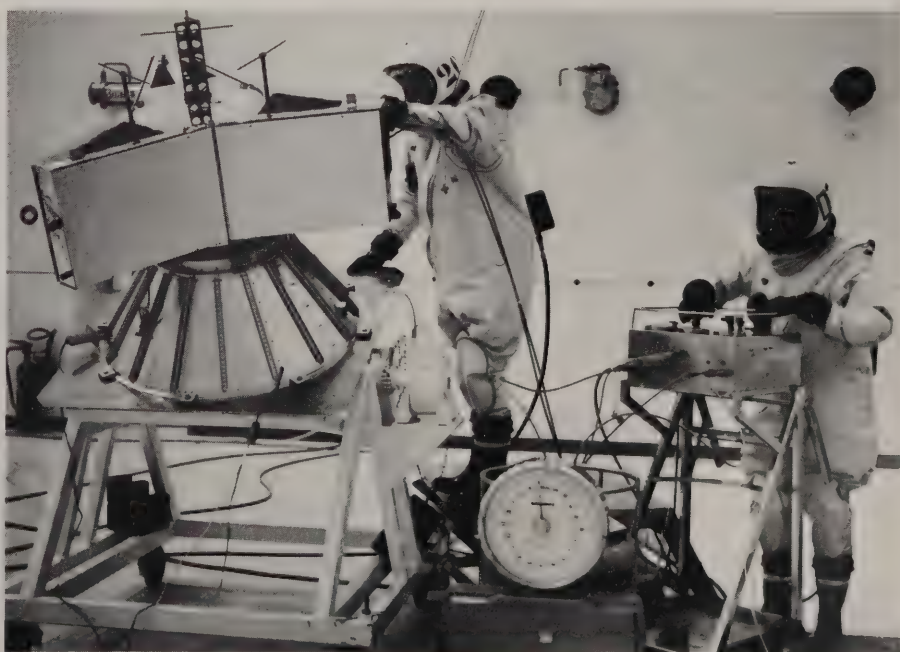
In the week subsequent to launch much speculation and theorizing had transpired in an attempt to explain the poor sun angle attained immediately upon deployment from the Sylva (the launcher cannister). All manner of suggestions appeared from silly to erudite...some brilliant even. None seemed satisfactory in that each explained only some of the symptoms and often appealed to some highly unlikely event or phenomenon as its key feature. One theory postulated an anomalous fuel-sloshing or turbulence in the tanks. Another version said that the fuel had partially frozen leading to a serious imbalance. And so forth. Finally, KA9Q postulated that the fundamental cause of the poor sun angle had more to do with spin rate at deployment than any exotic effect of fuel turbulence or freezing. His theory is widely accepted now because it explains many of the symptoms and requires only a simple malfunction to generate to observed effects.

The cause of the hypothetical malfunction is now the subject of close scrutiny in Europe and the U.S.

Meanwhile, the spacecraft continued to spin down until by Friday, 24 June its angular velocity was down to a slow 1.6 RPM. It had been designed to spin at 10 RPM at this stage. The spacecraft obtains its stability in orbit by spinning; it's simple and inexpensive to stabilize that way. The magnetorquers are used not for stationkeeping but rather for orientation changes. But when the spinning stops or slows, just as with a toy top or gyro, stability is lost and undesirable motions such as precession and nutation can occur. So when AO-10 reached 1.6 RPM, it was clear action was required.

So on the evening of 24 June (25 June UTC) software instructions previously uploaded by DJ4ZC to AO-10 were executed by the IHU (Integrated Housekeeping Unit; the computer on AO-10). The first session of magnetorquing was under way. The result was highly successful and the spacecraft's angular velocity (spin rate) was increased to about 6 RPM. The cw telemetry "Spin" parameter was found to be in error because, as a result of the "backward" spin and the low sun angle, the IHU was "unsure" of the actual spin rate. But more time had been bought. Most important of all, the spin up had also included a re-orientation maneuver. The latter had vastly improved the sun angle; it was now very nearly perfect. Later, the Mode B beacon was placed on 100% duty cycle. The cw telemetry showed the improved sun angle had helped further warm AO-10 too. Occasionally the temperatures would rise to close to 10 degrees C; downright cozy compared to the frigid temps it had seen the week earlier!

Then early on 30 June UTC the next spin up maneuver was performed. As before on 25 June UTC there was no attempt to spin down from the negative direction to a positive direction (the "right" way) since there is no inherent preference of the spacecraft for either spin direction. The software can be



Loading the highly toxic propellants. Left: W. Mueller; right is W4PUJ

adapted easily. There IS, however, a strong desire to avoid the low-rev regime (low spin rates) since there is the possibility of instability (wobble) at the low spin rates. Thus from the initial -2.5 RPM or so at deployment to the -1.6 on 25 June, we accelerated to -7 RPM and on 30 June to -18 . Precision measurements made by WA2LQQ and K1HTV on 30 June established the spin rate then (0320 UTC) at 18.68 ± 0.01 RPM. These precision measurements were made by noting the nulls and peaks of the antenna pattern swept across the receive site by the spinning spacecraft. Long strip chart recordings and precise time increment measurements led to the result. On Thursday, 30 June, DJ4ZC indicated the command team would likely strive for "about 40 RPM" prior to the first kick motor firing.

At press time the best estimate of the date of kick motor firing is 5 to 7 July. Additional spin up and reorientation maneuvers were to be accomplished over the Fourth of July Weekend.

AMSAT OSCAR 10 contains a small rocket engine designed to boost it from its initial orbit to one that is better for its intended purpose: Amateur Radio communications. The low inclination and low perigee (low point) of the initial "transfer ellipse orbit" have some severe limitations. First, with a low inclination, it does not serve well those in latitudes distant from the equator; further than about N 45 or S 45 it's always very low on the horizon since the maximum latitude it travels from the equator is the same as the inclination of the orbit. Right now, AO-10's orbit is inclined 8 degrees. Later it will be increased to 57 or 58 degrees. With the low perigee, moreover, the orbital lifetime is limited to a few months or so. So there are good reasons to boost to a new orbit.

AMSAT OSCAR 10 will be boosted to its final orbit in two steps. The first step will raise the perigee to perhaps 1000-1500 km from its initial 200 km and simultaneously raise the inclination to 10 to 15 degrees. (Many of the variables affecting the PRECISE values to be sought are being analysed and optimized now, so the exact values are not yet set.) The first burn of the liquid fuel, apogee kick motor will last between 35 and 45 seconds and consume about 15% on the propellants: N_2O_2 (nitrogen tetroxide) and UDMH (unsymmetrical dimethyl hydrazine). The second burn will take place within about two weeks and burn the remaining fuel to depletion. The second burn will raise the perigee slightly and the inclination a great deal. It is hoped that the inclination can be raised to about 58 degrees. The exact value attained will depend on a host of factors including the efficiency of the motor and the mass of the spacecraft, the precision of the firing attitude and so forth.

The second motor firing may occur in mid-July. If it does, the initial transponder use by the general Amateur Radio community can be expected shortly thereafter; perhaps within a few days. So mid-July is the best guess on when the doors will be open. This is, of course, subject to the successful, timely completion of those several tasks remaining.

Until the transponders are available for general use as announced by AMSAT HQ, the transponders should not be used. If you hear them on, resist the temptation to ker-

chunk the passband. Chances are that you'll interfere with ranging tests and your kerchunk may pollute the data necessary to measure the orbit precisely.

At press time the best orbital information was coming through informal channels rather than the formal NASA Goddard source. The problem is that this object (AO-10) is small (low radar cross-section) and is in deep space. It is thus difficult to track over the short term. In fact, the initial NASA "predicts" appear to be for the wrong object. The catalog number for AO-10 is 14129 but another object has apparently been mistaken for AO-10 and information disseminated on the spurious object in place of AO-10. For now, the best elements available are those included elsewhere in this issue.

The first two weeks in the life of AO-10 have been exciting, albeit occasionally worrisome. The spacecraft has proven to be superb in every sense. Even when operated substantially outside of its design envelope, it has recovered perfectly. It is truly a magnificent machine worthy of the pride a million amateurs world-wide now feel in their newest, most advanced OSCAR.

Back issues of most ORBITS are available for \$2 and a 9 by 12 inch S.A.S.E. to AMSAT Hq., P.O. Box 27, Washington, DC 20044.



Depositing Phase IIIB in the SYLDA.

Satellite Log

By Geoffrey Falworth*

Satellite Log features launches into orbit since the beginning of 1980. The satellite name is that assigned by the launching agency (the international designation is in parenthesis) and the orbit (period, inclination to Earth's equator, apogee height, perigee height) is for shortly after launch; later maneuvers may modify this orbit. Transmissions are those which are publicly reported or assumed from the type of spacecraft involved.

Cosmos 1423 (1982-115A) launched on 1982 Dec 8; initial orbit: 94.21 min, 62°.84, 579 km, 283 km; transmissions: none reported. Molniya 1-class spacecraft failed to leave low parking orbit.

Meteor 40 (1982-116A) launched on 1982 Dec 14; initial orbit: 102.01 min, 81°.25, 892 km, 814 km; transmissions: 137.300 MHz. Meteor 2-class weather satellite.

Cosmos 1424 (1982-117A) launched on 1982 Dec 16; initial orbit: 89.73 min, 64°.90, 351 km, 172 km; transmissions: none reported. Recoverable reconnaissance satellite.

Operations 9845 (1982-118A) launched on 1982 Dec 21; initial orbit: 101.37 min, 98°.73, 828 km, 816 km; transmissions: 136.770 MHz, 137.500 MHz, 137.620 MHz, 137.770 MHz, 1698.000 MHz, 1702.500 MHz, 1707.000 MHz. Defense Meteorological Satellite Program spacecraft.

Cosmos 1425 (1982-119A) launched on 1982 Dec 23; initial orbit: 90.32 min, 69°.96, 351 km, 230 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1426 (1982-120A) launched on 1982 Dec 28; initial orbit: 90.30 min, 50°.63, 384 km, 200 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1427 (1982-121A) launched on 1982 Dec 29; initial orbit: 94.04 min, 65°.84, 496 km, 448 km; transmissions: none reported. Radar calibration and military test satellite.

Cosmos 1428 (1983-01A) launched on 1983 Jan 12; initial orbit: 104.75 min, 82°.93, 1007 km, 956 km; transmissions: 150.000 MHz. Navigation satellite.

Cosmos 1429 (1983-02A) launched on 1983 Jan 19; initial orbit: 114.91 min, 74°.03, 1516 km, 1487 km; transmissions: none reported. Military communications satellite.

Cosmos 1430 (1983-02B) launched on 1983 Jan 19; initial orbit: 115.65 min, 74°.03, 1502 km, 1468 km; transmissions: none reported. Military communications satellite.

Cosmos 1431 (1983-02C) launched on 1983 Jan 19; initial orbit: 115.45 min, 74°.04, 1487 km, 1466 km; transmissions: none reported. Military communications satellite.

Cosmos 1432 (1983-02D) launched on 1983 Jan 19; initial orbit: 115.25 min, 74°.03, 1468 km, 1466 km; transmissions: none reported. Military communications satellite.

Cosmos 1433 (1983-02E) launched on 1983 Jan 19; initial orbit: 115.01 min, 74°.03, 1463 km, 1449 km; transmissions: none reported. Military communications satellite.

Cosmos 1434 (1983-02F) launched on 1983 Jan 19; initial orbit: 114.88 min, 74°.03, 1467 km, 1432 km; transmissions: none reported. Military communications satellite.

Cosmos 1435 (1983-02G) launched on 1983 Jan 19; initial orbit: 114.65 min, 74°.03, 1463 km, 1416 km; transmissions: none reported. Military communications satellite.

Cosmos 1436 (1983-02H) launched on 1983 Jan 19; initial orbit: 114.56 min, 74°.03, 1468 km, 1402 km; transmissions: none reported. Military communications satellite.

Cosmos 1437 (1983-03A) launched on 1983 Jan 20; initial orbit: 97.61 min, 81°.17, 658 km, 628 km; transmissions: none reported. Electronic surveillance satellite.

InfraRed Astronomy Satellite 1 (1983-04A) launched on 1983 Jan 26; initial orbit: 103.10 min, 99°.11, 912 km, 897 km; transmissions: 2253.000 MHz. Infrared celestial survey spacecraft.

Plasma Interaction Experiment 2 (1983-04B) launched on 1983 Jan 26; initial orbit: 102.42 min, 100°.12, 890 km, 852 km; transmissions: none reported. Instrumentation on Delta second stage to measure space plasmas and their effects on spacecraft structures.

Cosmos 1438 (1983-05A) launched on 1983 Jan 27; initial orbit: 88.89 min, 70°.39, 230 km, 209 km; transmissions: none reported. Recoverable reconnaissance satellite.

Communications Satellite 2A (1983-06A) launched on 1983 Feb 4; initial orbit: 1436.07 min, 0°.12, 35791 km, 35788 km; transmissions: 2286.500, 3735 to 3915, 3820.000, 3985 to 4165, 4080.000, 17810 to 17940, 18090 to 18220, 18370 to 18500, 18650 to 18780, 18930 to 19060, 19210 to 19340, 1945.000 MHz. Japanese communications satellite at 131°.98 East.

Satellite News: The news bulletin of satellites, spacecraft and space activity is available in four editions: *Space Objects Digest*, *Military Space Digest*, *Space Operations Review* and *Space Systems Digest*. The price is 25 cents per issue; subscribe for as many issues as you like. Payments and orders by International Money Order, cash or check. Please add \$2 to personal checks for UK bank charges. Orders should be sent to: Geoffrey Falworth, 12 Barn Croft, Penwortham, Preston PR 10 SX, England.

OSCAR 10 EQUIPMENT

- **Antennas/Accessories**
KLM 420-450-18C,
143-150-14C, circularity
switches, splitters,
fiberglass mast/booms
- **Rotors**
Kenpro KR400, KR500
- **Amplifiers**
Mirage D1010(N),
D24(N), B1016, B3016
- **Preamps**
Lunar GaAsFET,
regular or mast mount,
2m, 70cm
- **Power Supplies**
Astron 12 Vdc Models
from 4A to 50A;
metered and nonmetered
- ★ **New ICOM IC-471**
all-mode 430-450 rig.
Fantisite!
- ★ **New ICOM IC-271**
all mode 2-meter rig.
Marvelous!

Quality Assured!

KJI Electronics

66 Skytop Road
Cedar Grove, NJ
07009

Call 7-11 P.M.
201-239-4389

LET'S TALK OSCAR



DATA IS DERIVED FROM OBSERVATIONS BY
PROVIDE OSCAR REPRODUCTION AUTHORITY
SEAL-ADDRESSED STAMPED ENVELOPE
FOR AR-100 BY 35 LOS ALTOS CA 94033
IN THE LATEST AVAILABLE DATA
C. POINT THE AMATEUR SATELLITE
AMSAT-OSCAR-101 WASHINGTON DC 20044
COMPILED AND COORDINATED BY JOHN PRONKO W6XN
RANDY COLE KN6W AND JACK SOMERS WA6VGS
PRINTED BY Henry Radio

**AT HENRY RADIO
WE'RE DEDICATED TO EVERY
ASPECT OF AMATEUR RADIO
...FROM THE EXCITING AND SOPHISTICATED
TECHNOLOGY OF TODAY TO HELPING THE
YOUNG NOVICE GET HIS FIRST SIGNAL ON THE AIR.**

**AND OUR OSCAR 8 & 9 ORBITAL DATA
SHEETS AREN'T ALL WE HAVE TO OFFER**

★ "HAM IN SPACE" TEE SHIRTS

★ ORBIT MAGAZINE

★ L & R POLARIZED ANTENNAS

★ QSL CARDS

★ AMSAT BADGES

★ LINEAR AMPS

★ TRANSCEIVERS FOR OSCAR
MODES A, B & J

- ICOM
- KENWOOD
- YAESU

★ RECEIVING PRE-AMPS

★ ORBIT PLOTTERS

★ ASTRON POWER SUPPLIES

★ AZMUTH & ELEVATION ROTORS

★ ORBIT CALENDARS

IN FACT, WE HAVE IT ALL...WE ARE OSCAR SPECIALISTS!

**HENRY RADIO leads the way. Let us answer your
questions and help you with your needs. Give us a call—
at the L.A. store ask for Jack (WA6VGS)**



Henry Radio

2050 S. Bundy Dr., Los Angeles, CA 90025 (213) 820-1234
931 N. Euclid, Anaheim, CA 92801 (714) 772-9200

TOLL FREE ORDER NUMBER: (800) 421-6631
For all states except California.
Calif. residents please call collect on our regular numbers.

Satellites & 73



When it comes to covering satellite communications, 73 runs rings around the competition. 73 publishes more articles about satellites and TVRO than any other ham radio magazine.

- more OSCAR articles
- more LISTENING articles
- more TVRO articles

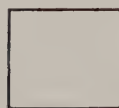
In fact, since January of 1982, satellite-related articles have averaged 25% of the total number of articles published per issue of 73. The most recent of those covered such topics as:

- OSCAR Tracking Antennas
- PHASE III
- OSCAR By The Numbers

And our regular monthly feature "SATELLITES" contains the latest AMSAT news, news of the Soviet satellites, OSCAR orbits, and more.

Learn more about satellite communications—subscribe to 73 Magazine and receive 12 monthly issues for only \$19.97. Simply complete the coupon below (a photocopy is acceptable) and mail it to:

73 Magazine
P.O. Box 931
Farmingdale NY 11737



YES!

I want 12 issues of 73 for only \$19.97.

☐ Check Enclosed ☐ Bill Me ☐ VISA ☐ MC ☐ AMEX

Card# _____ Exp. date _____

Signature _____ Interbank # _____

Name _____

Address _____

City _____ State _____ Zip _____

Canada and Mexico—\$22.97 1 year US funds only

Foreign surface—\$39.97 1 year US funds drawn on US bank only

Foreign Airmail—Please Inquire

Allow 6-8 weeks for delivery.

73 Magazine • PO Box 931 • Farmingdale NY • 11737

728RBT

VHF – UHF – SHF – PRODUCTS

Phase III - Equipment



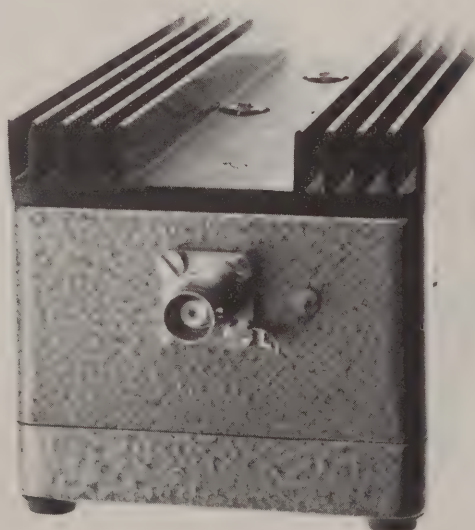
LSM 24 23-cm TRANSMITTER MIXER

INPUT FREQUENCY : 144 - 146
INPUT POWER : 0.1 - 10
OUTPUT FREQUENCY : 1268 - 1270

MHz
W
MHz

LINEAR OUTPUT POWER : 0.5
SUPPLY VOLTAGE : 13.8
PRICE \$: ON REQUEST

W
V



NEW!
**DISTRIBUTOR FOR
THE UNITED STATES**
THE VHF SHOP
GERRY RODSKI
BOX 349 RD 4

Mountaintop, Pa. 18707

PA 2310 LINEAR POWER AMPLIFIER

FREQUENCY RANGE : 1250 - 1300
DRIVE POWER : 0.5
OUTPUT POWER : 10
SUPPLY VOLTAGE : 13.8
PRICE \$: ON REQUEST

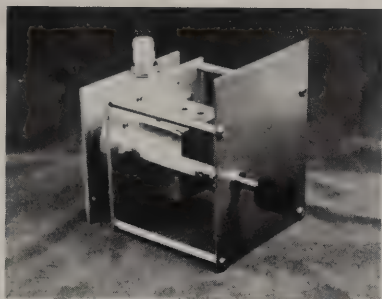
MHz
W
W
V

Send 6 IRC's for fully detailed catalogue „COMPONENTEN & SYSTEME“ giving you complete informations about PREAMPS, CONVERTERS, TRANSVERTERS and rare components. (In German language)

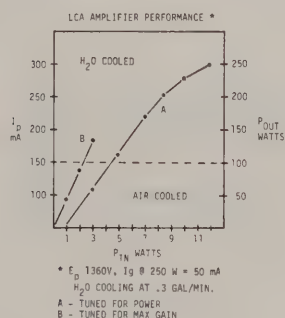


Postfach 199 5860 Iserlohn W.-Germany
Tel. (0 23 71) 5 04 44 Telex 827 803 ssb d

Cavity Power Amplifier 1240 to 1300 MHz



- Single 2C39/7289 tube.
- 50-ohm in & out; no stub tuner req'd.
- 250 watts maximum output.
- Tunes the entire band with front panel control.
- No exposed high voltage while tuning.
- Ptf (Teflon) anode tuner, no moving metal parts.
- Convenient remote mounting.
- Silver plated 1/8th inch copper plates, heavy aluminum construction for thermal stability.
- Supplied with H₂O cooling and bias switching information.
- Obtain max. OSCAR 10 ERP with one watt drive and 6 foot loop Yagi or a quad helix.
- Over 14,000 hours of continuous operation to date.
- Adjustable output loading control.



- Model LCA without tube \$275
- Delivery 14 to 45 days.
- Screw on H₂O jackets for 2C39/7289, anodized aluminum, with gasket. . \$15

Other Angle Linear Products:

- GaAsFET preamplifiers on any freq. up to 3 GHz.
- Time delay sequence generators for automatic T-R switching, coaxial relay and preamplifier protection.
- Write for data sheets.

Prices and specifications subject to change without notice. Calif. residents add 6 1/2 percent sales tax.

Chip Angle, N6CA (LM 135)

Angle Linear

P. O. Box 35
Lomita, CA 90717

High Performance

vhf/uhf preamps

EME
Scatter
Tropo
Satellite
ATV
Repeater
FM Equipment
Radio Telescope



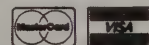
NEW GaAsFETs!

	Freq. Range (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
P28VD	28-30	<1.1	15	0	DGFET	\$29.95
P50VD	50-54	<1.3	15	0	DGFET	\$29.95
P50VDG	50-54	<0.5	24	+12	GaAsFET	\$79.95
P144VD	144-148	<1.5	15	0	DGFET	\$29.95
P144VDA	144-148	<1.0	15	0	DGFET	\$37.95
P144VDG	144-148	<0.5	24	+12	GaAsFET	\$79.95
P220VD	220-225	<1.8	15	0	DGFET	\$29.95
P220VDA	220-225	<1.2	15	0	DGFET	\$37.95
P220VDG	220-225	<0.5	20	+12	GaAsFET	\$79.95
P432VD	420-450	<1.8	15	-20	Bipolar	\$32.95
P432VDA	420-450	<1.1	17	-20	Bipolar	\$49.95
P432VDG	420-450	<0.5	16	+12	GaAsFET	\$79.95

Advanced Receiver Research

Box 1242 • Burlington CT 06013 • 203 582-9409

Preamps are available without case and connectors: subtract \$10. Other preamps available in the 1 - 800 MHz range. Prices shown are postpaid for U.S. and Canada. CT residents add 7 1/2% sales tax. C.O.D. orders add \$2. Air mail to foreign countries add 10%.



SWITCH 2 OR 3 OR 6 OR 9 ANTENNAS OVER ONLY ONE COAXIAL FEEDLINE With INLINE "wireless" weatherproof coaxial relays you simply add more antennas without costly control cables.

For years to come sun spot activity will make 10, 15 and 20 meters less attractive because of their decreasing reliability. You can enjoy long distance and reliable operation on the lower bands with vertical or wire antennas by creating simple 2 element arrays. Remember—efficient antennas create highest effective radiated power. Avoid wasting RF power and radiating efficiency using band traps and antenna tuners. Instead, you can switch antennas and get up to 10db more signal into that distant point. You will also receive better because traps and antenna tuners do not provide an effective signal gathering area to a passing wave. INLINE relays can be installed virtually anywhere without expensive and unsightly multiwire control cables. They can be placed in the attic, on the roof, on a mast, on a tree, on a tower, anywhere the antennas are. They are ideal in apartment houses to overcome restrictions. They minimize hole drilling and eliminate a rat's nest of wires. INLINE relays are available in two position and three position types, either wired or "wireless". Wired types require 1 conductor + ground.

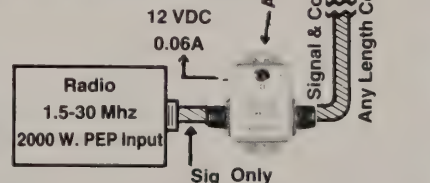
Two position relays

Type 101A - DC to 180 MHz - \$32.95 - Wired
Type 107* - DC to 970 MHz - \$48.95 - Wired
Type 105 - 1.5 to 180 MHz - \$54.95 - Wireless
Type 108* - 25 to 970 MHz - \$74.95 - Wireless

Three position relays

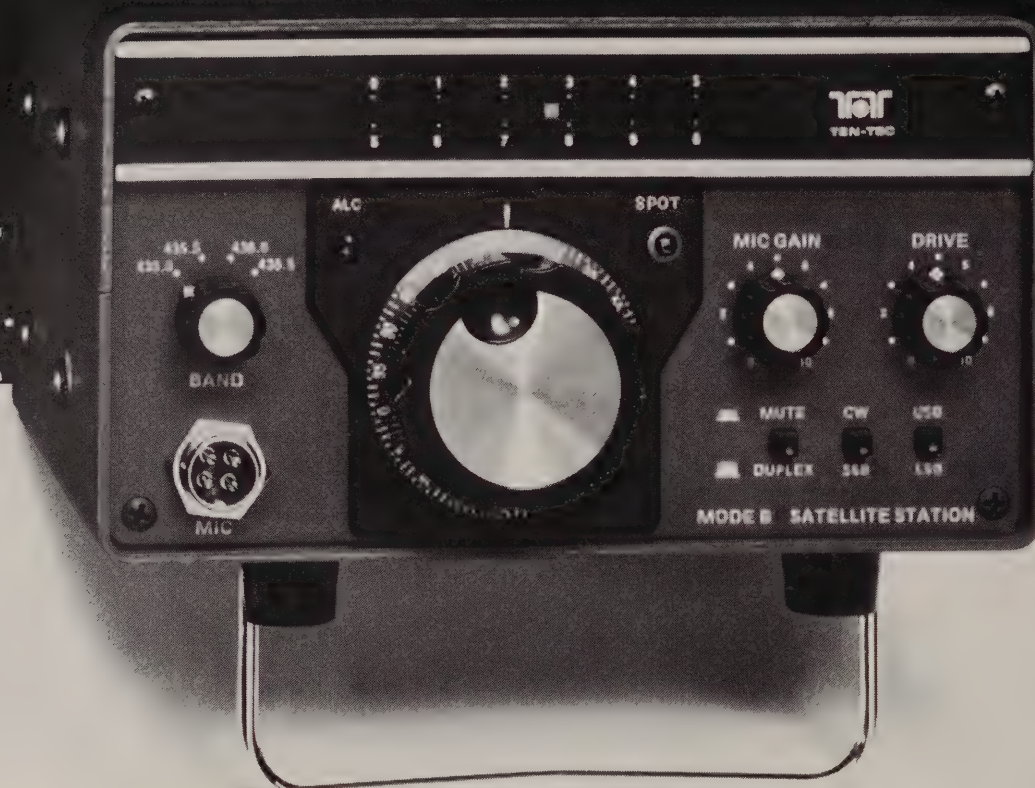
Type 1013 - DC to 180 MHz - \$49.95 - Wired
Type 1053/105C - 1.5 to 180 MHz - \$79.95 - Wireless

Type 1053/105C Illustrated



Other types, all frequencies available. Relay power ratings decrease with increased freq. See literature for detailed chart. Distributed worldwide. Literature and application data upon request. If not in stock at your dealer order direct. Add \$2.00 for surface UPS. \$3.50 for UPS Blue or Parcel Post. Overseas shipping at our cost. VISA, Mastercard accepted. Unadilla/Reyco/In-Line Division 6743 Kinne St. East Syracuse, NY 13057 315-437-3953

Here's the easiest, lowest-cost way to use the OSCAR 10 Satellite



New TEN-TEC Satellite Station.

It's easy. The new TEN-TEC Model 2510 simplifies station assembly, reduces the number of interconnections, and makes operating easier.

It's low cost. Eliminates buying separate converters and another HF rig.

It's full duplex. The 2510 is a 435 MHz, 10-watt SSB/CW transmitter and a 2-to-10 meter receive converter all in one package to give you full duplex transmit/receive functions in Mode B. It converts your HF station into an OSCAR station!

Just add antennas, rotators, a 100-watt "brick," and go. The 2510 transmitter section has a frequency range of 435 to 435.5 MHz (up to 437 MHz with optional board), adjustable ALC, and full controls. Main Tuning sets uplink frequency. Spot Control helps find your downlink signal. Drive Control, Microphone Gain, Band Switch, and Push-Button switches complete the front panel. Push-Button switches are: DUPLEX/MUTE (for duplex operation or for disabling receive converter during transmit); CW/SSB selects mode; USB/LSB selects sideband. The receive converter frequency coverage is 144 to 146 MHz (converted to 28 to 30 MHz) with dynamic range of 85 dB typical. Rear panel connectors are provided for antennas, amplifiers, key, 12Vdc input, and HF receiver.

Enjoy the most exciting event in Amateur radio today—with the new TEN-TEC Satellite Station. See your dealer or write for information to TEN-TEC, Inc. Sevierville, TN 37862.

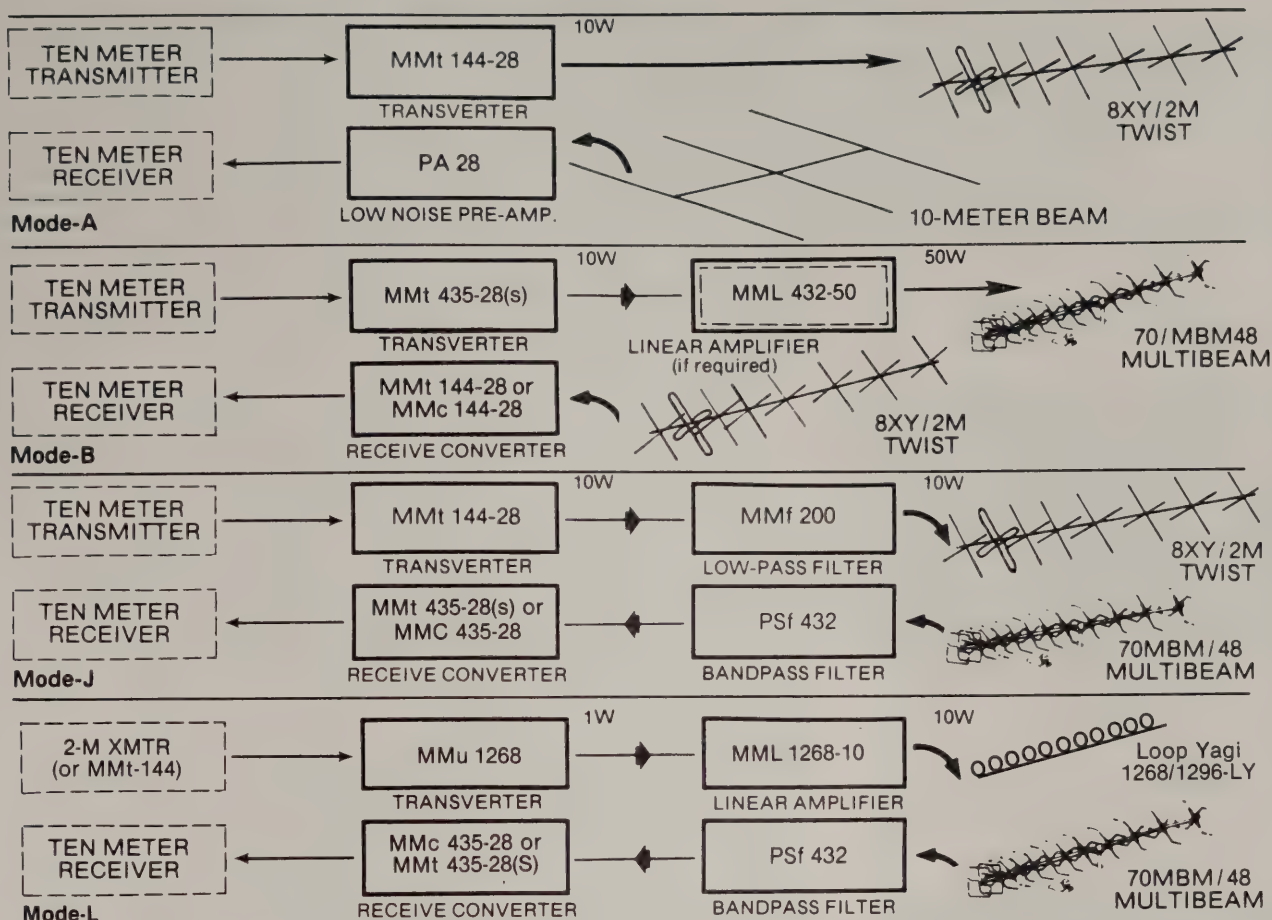
Here's all you need to use OSCAR 10

1. TEN-TEC Model 2510 Satellite Station (requires 12Vdc @ 2A).
2. Your present 10-Meter transceiver or receiver.
3. 2-Meter, circularly polarized antenna, 10 dBi gain or greater (Cushcraft, KLM).
4. 435 MHz, circularly polarized antenna, 12 dBi gain or greater (Cushcraft, KLM).
5. Optional 50-100 watt 435 MHz linear amplifier (Mirage, Tokyo High Power).*
6. Rotators for azimuth and elevation (Alliance, Hygain/Telex, Spectrum West).
7. 12Vdc power source capable of supplying all equipment requirements.

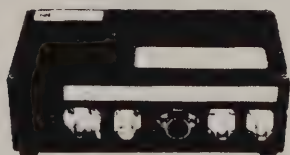
*Output power requirements: refer to April 1983 QST. AMSAT recommends 500/1000 Watts ERP (effective radiated power) on 435 MHz. For example: 100 watts into a 12 dBi gain antenna yields 1000 watts ERP (assumes 2 dB feedline loss).



OSCAR SYSTEMS FROM SPECTRUM INTERNATIONAL



CONVERTERS AND TRANSVERTERS FOR



OSCAR-8
UoSAT/OSCAR-9
OSCAR-10
 (Phase III)

Specifications:

Output Power: 10W
 Receiver N.F. 3 dB Typ.

Receiver Gain: 30 dB Typ.
 Prime Power: 12 Vdc

Receive Converters:

MMc 144 \$59.95
 MMc 435-28(s) \$69.95
 MMc 435-28(TC) \$69.95

UHF Filters:

MMf 200-5 \$31.95
 MMf 200-7 \$42.95
 PSf 432 \$74.95

Mod. kit to adapt original MMt 432-28 to Mode-J oper: \$26.50

AMSAT/OSCAR-10 Mode-L Equipment:

Transverters: 3 Models - selection of 10, 6, 2-meter i-fs.
 Transmit only converters: 2 Models - sel. of 10, 6, 2-meter i-fs.
 Receive only converters: 3 Models - sel. of 10, 6, 2-meter i-fs.
 Antennas: Loop-Yagis, single, twin and quad stacking.
 Tx Power Amps (Transistor): 3 Models, 1/2W/1W input; 8W, 10W, 17W output.

Transverters by Microwave Modules and other manufacturers can convert your existing low-band rig to operate on the vhf and uhf bands. Models also available for 2m to 70cm and for ATV operations from ch2/ch3 to 70 cm. Each transverter contains both a Tx up-converter and an Rx down-converter. Write for details of the largest selection available.

Attention owners of the original MMt 432-28 models: Update your transverter to operate OSCAR-8 and AMSAT/OSCAR-10 (Phase III) by adding 435-to-437 MHz range. Mod. kit including full instructions is \$26.50 plus \$1.50 shipping.

ANTENNAS

2-Meter 8 + 8 twist Model 8XY/2M\$62.40
 Phasing Harness Model PMH/2C\$13.35
 48 el. 70 cm Multibeam Model 70-MBM-48 75.75
 88 el. 70 cm Multibeam Model 70-MBM-88\$105.50

(All prices FOB Concord, Massachusetts)

Send 40¢ (2 stamps) for full details of KVG crystal filters and other products to fill all of your VHF/UHF equipment needs.

Preselector Filters • Amplifiers • SSB Transverters
 Varactor Triplers • Counters • FM Transverters
 Antennas • Decade Prescalers • VHF Converters
 Oscillator Filters/Crystal Filters • UHF Converters
 AMSAT/OSCAR-10 Mode-B and Mode-L equipment

Master Card, VISA accepted.

si

**Spectrum
 International, Inc.**
 Post Office Box 1084R
 Concord, MA 01742 USA



Your Satellite Headquarters Electronic Equipment Bank

516 Mill Street N.E. Vienna, VA 22180

Order Toll Free 800-368-3270

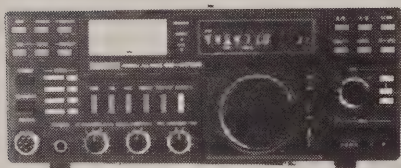
Yaesu



Yaesu FT-726R V/UHF All Mode Tribander

- ★ Three Bands
- ★ 70 cm GaAsFET preamp
- ★ SSB, CW, FM
- ★ 20 Hz/Tuning steps
- ★ Speech Processor
- ★ Eleven memories
- ★ Band scan
- ★ VFO data exchange
- ★ Satellite Operation
- ★ Dual meters
- ★ built-in power supply
- ★ AGC, Noise Blanker, Squelch
- ★ Memory backup
- ★ I-F Shift
- ★ CW Filter option
- ★ VOX/CW Semi break-in

ICOM



ICOM VHF/UHF Transceivers

- IC-271A:
 - ★ 25 watts output
 - ★ 32 Memories
 - ★ Subaudible tones
 - ★ PLL to 10 Hz
 - ★ High visibility display
 - ★ Scanning
 - ★ Dual VFOs
- IC-471:
 - ★ 32 Memories
 - ★ Subaudible tones
 - ★ PLL to 10 Hz
 - ★ Scanning
 - ★ 430-450 MHz
 - ★ 1 MHz up/down
 - ★ Offset for memory

Antennas

CUSHCRAFT
HY-GAIN
KLM
TET

Rotors

KENPRO
CDE (Telex)
ALLIANCE

Amplifiers

LUNAR
MIRAGE
TOKYO HY-PO

Power Supplies

ASTRON

LNA Converters

LUNAR

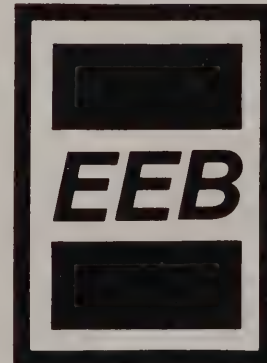


EEB is your one-stop place to shop for OSCAR-10
Please call us for pricing information:
800-368-3270 Va. 703-938-3350

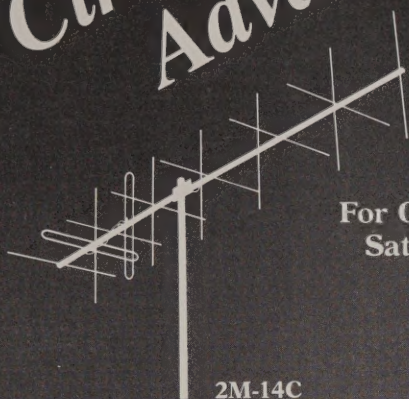
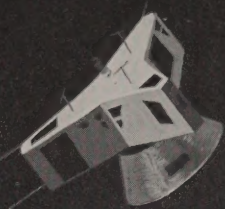
Tues. Wed. Fri. 10 A.M. - 5 P.M.
Thurs. 10 A.M. - 9 P.M. Sat. 10 A.M. - 4 P.M.
Closed Sunday and Monday

We accept VISA/MC Sorry no COD

Plan to visit us the next time you're in Washington



The Circular Advantage



For OSCAR 10 and Russian
Satellite Communications

2M-14C

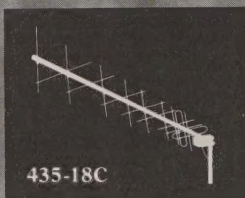
KLM's Circular Polarized antennas have been specifically designed to optimize OSCAR 10 and Russian satellite operation. Quality workmanship and superior design, yield virtually perfect circular patterns over the satellite operational bandwidth. Enjoy less Multi-Path Distortion, less Flutter, Fade, and better S/N Ratios, with comparable performance on transmit.

Both the 2M-14C and 435-18C sport virtually unbreakable 3/16" rod parasitic elements anchored thru the boom, folded dipole driven elements produce excellent physical and electrical symmetry for years of constant performance.

Specifications: (2M-14C)

BANDWIDTH: .. 144-150 MHz	BOOM LENGTH: 12'9"
GAIN: 11 dBdc	VSWR: 1.2:1
BEAMWIDTH: 48°	WINDLOAD: 1.25 sq. ft.
FEED IMP: 50 ohm unbal.	WT. (LBS): 7.5
BALUN: 4:1, 2KW	ELLIPTICITY: ±3 dB Max.
CIRCULARITY SWITCHER:	INCLUDED

The 435-18C is a star performer, an optional CS-2 circularity switcher puts left, and right-hand circular control in your shack, and doubles as a two port divider/impedance transformer for single feed line convenience.



435-18C

Specifications: (435-18C)

BANDWIDTH: .. 420-450 MHz	GAIN: 12 dBdc
BOOM LENGTH: 7.3 ft.	VSWR: 1.5:1
BEAMWIDTH: 44°	FEED IMP: 50 ohm unbal.
WT. (LBS): 4.5	BALUN: 2- 4:1, 1KW
MAST DIA: Cen-Rear/1½"	ELLIPTICITY: 3dB MAX.
CIRCULARITY SWITCHER	(CS-2) OPTIONAL

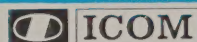
See your local KLM dealer or write for our complete catalog

KLM electronics Inc.

P.O. Box 816, Morgan Hill, CA 95037

Order All Ham Radios & Accessories from **C-COMM**

We have the
**Products,
Prices,
and Service**
that bring you back!



IC-451A

The perfect high performance UHF transceiver for satellite use. 10 watt transmitter, 10 Hz tuning, mast mounted preamp available, scanning. Use for mode B uplink and mode J downlink. Incomparable performance at an unbelievable price.

Regular \$899

**CLOSEOUT
SPECIAL!
\$599**

**C-
comm**

Call Toll FREE Nationwide!
800-426-6528
(Incl. Alaska & Hawaii)

Wash. Residents: Add applicable sales tax. Call: 800-562-6818

International Orders:
Telex: 15-2391 C-COMM

C-COMM

6115 15th Ave NW, Seattle, WA 98107
(206) 784-7337

**The BEST is still
"made in U.S.A."**



MIRAGE

**American made RF Amplifiers and Watt/ SWR Meters
of exceptional value and performance.**

• 5 year warranty • prompt U.S. service and assistance

RF AMPLIFIERS

2 METERS-ALL MODE

B23 2W in = 30W out \$89.95
(useable in: 100 mW-5W)

B108 10W in = 80W out \$179.95
(1W = 15W, 2W = 30W) RX preamp

B1016 10W in = 160W out \$279.95
(1W = 35W, 2W = 90W) RX preamp

B3016 30W in = 160W out \$239.95
(useable in: 15-45W) RX preamp
(10W = 100W)

220 MHz ALL MODE

C106 10W in = 60W out \$199.95
(1W = 15W, 2W = 30W) RX preamp

C1012 10W in = 120W out \$289.95
(2W = 45W, 5W = 90W) RX preamp

C22 2W in = 20W out \$89.95
(useable in: 200mW-5W)

RC-1 AMPLIFIER

REMOTE CONTROL \$24.95
Duplicates all switches, 18' cable

WATT/ SWR METERS

- peak or average reading
- direct SWR reading

MP-1 (HF) 1.8-30 MHz

MP-2 (VHF) 50-200 MHz \$119.95

430-450 MHz ALL MODE

D24 2W in = 40W out \$199.95
(1W = 25W)

D1010 10W in = 100W out \$319.95
(1W = 25W, 2W = 50W)

Available at local dealers throughout the world.

MIRAGE
COMMUNICATIONS EQUIPMENT, INC.

P.O. Box 1393, Gilroy, CA 95020 (408) 847-1857

YAESU FT-726R TRIBANDER

NEW GALAXIES OF PERFORMANCE ON VHF AND UHF

FULL DUPLEX!!

SATELLITES!!

SCATTER!!

FM!!

EME!!



The New Yaesu FT-726R Tribander is the world's first multiband, multimode Amateur transceiver capable of full duplex operation. Whether you're interested in OSCAR, moonbounce, or terrestrial repeaters, you owe yourself a look at this one-of-a-kind technological wonder!

Multiband Capability

Factory equipped for 2 meter operation, the FT-726R is a three-band unit capable of operation on 10 meters, 6 meters, and/or two segments of the 70 cm band (430-440 or 440-450 MHz), using optional modules. The appropriate repeater shift is automatically programmed for each module. Other bands pending.

Advanced Microprocessor Control

Powered by an 8-bit Central Processing Unit, the ten-channel memory of the FT-726R stores both frequency and mode, with pushbutton transfer capability to either of two VFO registers. The synthesized VFO tunes in 20 Hz steps on SSB/CW, with selectable steps on FM. Scanning of the band or memories is provided.

Full Duplex Option

The optional SU-726 module provides a second, parallel IF strip, thereby allowing full duplex crossband satellite work. Either the transmit or receive frequency may be varied during transmission, for quick zero-beat on another station or for tracking Doppler shift.

High Performance Features

Borrowing heavily from Yaesu's HF transceiver experience, the FT-726R comes equipped with a speech processor, variable receiver bandwidth, IF shift, all-mode squelch, receiver audio tone control, and an IF noise blanker. When the optional XF-455MC CW filter is installed, CW Wide/Narrow selection is provided. Convenient rear panel connections allow quick interface to your station audio, linear amplifier, and control lines.

Leading the way into the space age of Ham communications, Yaesu's FT-726R is the first VHF/UHF base station built around modern-day requirements. If you're tired of piecing together converters, transmitter strips, and relays, ask your Authorized Yaesu Dealer for a demonstration of the exciting new FT-726R, the rig that will expand your DX horizons!

Price And Specifications Subject To
Change Without Notice Or Obligation

YAESU
The radio.



483

YAESU ELECTRONICS CORPORATION 6851 Walthall Way, Paramount, CA 90723 • (213) 633-4007
YAESU CINCINNATI SERVICE CENTER 9070 Gold Park Drive, Hamilton, OH 45011 • (513) 874-3100

Watt's new...on 2 meters?



All mode (FM/SSB/CW) POWER, plus...!!!

TR-9130

The TR-9130 is a powerful, yet compact, 25 watt FM/USB/LSB/CW transceiver providing increased versatility of operation on the two meter band. It features six memories, memory scan, memory back-up capability, automatic band scan, all-mode squelch, and CW semi break-in. Available with a 16-key autopatch UP/DOWN microphone (MC-46), or a basic UP/DOWN microphone.

TR-9130 FEATURES:

- **25 watts RF output**
All modes, (FM/SSB/CW), utilize a new high power linear module, for more reliable FM operation and increased DX on SSB or CW.
- **FM/USB/LSB/CW all mode operation**
For added convenience in all modes of operation, the mode switch, in combination with the digital step (DS) switch, determines the size (100-Hz, 1-kHz, 5-kHz, 10-kHz) of the tuning or scanning step, and the number of digits displayed.
- **Six memories**
On FM, memories 1 through 5 for simplex or ± 600 -kHz offset, with the OFFSET switch. Memory 6 for non-standard offset. All six memories may be operated simplex, any mode.
- **Memory scan**
Scans memories in which data is stored.
- **Internal battery memory back-up**
With 9 volt Ni-Cd battery installed, (not Kenwood supplied), memories will be retained approximately 24 hours, adequate for the typical move from base to mobile. A terminal is provided on the rear panel for connecting an external back-up supply.
- **Automatic band scan**
Scans within selected whole 1-MHz segments (i.e., 144.000-144.9999-MHz).
- **Dual digital VFO's**
- **Repeater reverse switch**

- Transmit frequency tuning for OSCAR operations
- 16-key autopatch UP/DOWN microphone version
- Squelch circuit on all modes (FM/SSB/CW)
- Tone switch
- CW semi break-in circuit with sidetone
- Digital display with green LED's
- High performance receive-transmit design

A low-noise dual-gate MOSFET plus two monolithic crystal filters in the receiver front-end results in excellent two signal characteristics. Care in transmitter design assures clean signals in all modes.

- **Compact size and light weight**
170 (6-11/16) W x 68 (2-11/16) H x 241 (9-1/2) D mm (inch), 2.4 kg (5.3 lbs.).
- **Extended frequency range**
Covers 143.9 to 148.9999 MHz.
- **Transmit offset switch**
- **High performance noise blanker**
- **RF gain control**
- **RIT circuit for SSB/CW**
- **Amplified AGC**
- **HI/LOW power switch**
Selects 25 or 5 watts on FM or CW.
- **Accessory terminal**
- **Quick release mounting bracket**

Optional accessories for TR-9130, TR-9500:

- KPS-7 Fixed station power supply
- PS-20 Fixed station power supply (TR-9500 only)
- BO-9A System base with memory back-up supply
- SP-120 External speaker
- TK-1 AC adapter for memory back-up

More information on the TR-9130 and TR-9500 is available from all authorized dealers of Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220



TR-9500

70 CM SSB/CW/FM transceiver

- Dual digital VFO's cover 430-440 MHz in 100-Hz, 1-kHz, 5-kHz, 25-kHz, or 1-MHz steps. Transmit frequency tuning for OSCAR operations.
- USB, LSB, CW, and FM modes. Facilitates 70 cm OSCAR operations.
- 6 memories, with back-up terminal.
- Automatic band scan of entire band or any 1-MHz segment, memory scan, and SSB, CW search of selected 10-kHz segment.
- HI-10 W, LO-1 W, power output.
- Other convenient features include noise blanker, RIT (SSB, CW) RF gain control, FM squelch, CW sidetone, and basic UP/DOWN mic.

 **KENWOOD**
...pacesetter in amateur radio

Specifications and prices are subject to change without notice or obligation.